# WSR-88D Build 10 Training

**Presented by**
**the**
**WSR-88D OSF Operations Training Branch**

Version: 9809

# On the Cover

Tornado picture taken by Scott Woelm near Eldrige,
North Dakota on August 31, 1997.

# Table of Contents

# Preface

This training material provides a summary of the major changes in the WSR-88D Build 10.0 software that will impact RDA, UCP, and PUP operators. We recommend that UCP and PUP operators read this document before the Build 10.0 software arrives on-site. This document can then be added to the WSR-88D technical library for quick reference to support WSR-88D Build 10.0 operations.

Another training document for Build 10.0 is available in the Build 10.0 Release Kit, and is called “Quick Start Training for WSR-88D Software Release Build 10.0". This document walks the operator through the most critical new and revised UCP and PUP functions. The purpose of the Quick Start training is to help operators prepare to use their system operationally with the new Build 10.0 functionality.

A 2-hour teletraining session will be presented to each field site starting in late September 1998. This training session will be scheduled on a site-by-site basis. The teletraining class is based upon the material presented in this document. An on-line version of this document along with other Build 10 material can be found on the Internet at:

**http://www.osf.noaa.gov/otb/build10/**

The above training sequence is aimed at providing WSR-88D operators the capability to use their WSR-88D to support forecast and warning operations immediately after loading the Build 10.0 software.

## Acknowledgments

The Operations Training Branch would like to acknowledge our many colleagues that assisted in the preparation and review of this document. Members of the Applications, Engineering and Operations Branches of the OSF, and the National Severe Storms Laboratory answered questions, and provided thorough reviews of this document.

## Documentation

When the Build 10.0 documentation arrives, we encourage operators to study the portions that pertain directly to their operations. This document references the Build 10.0 documentation listed below:

1. Quick Start Training for WSR-88D Software Release 10.0
2. WSR-88D Operator Handbooks, Principal User Processor (Vol I-III)
3. WSR-88D Operator Handbook, Unit Control Position, Job Sheets (RPG sites only)
4. WSR-88D Guidance on Adaptable Parameters Handbooks (Vols 1 and 2).

## Compatibility Issues During Build 9 to Build 10 Transition

Build 10.0 offers several new products and algorithms and many enhancements to existing products and functionality. Some algorithms have been discontinued, and numerous software problems have been corrected. Minor compatibility problems will arise during the transition to Build 10.0. The loading of Build 10.0 on the RPG and its Associated PUPs should be coordinated through the Unit Radar Committee (URC).

### Build 9.0 PUP connected to Build 10.0 RPG

- TVS/ETVS alerts do not work properly and should be avoided
- Hybrid Scan Reflectivity (HSR) product will not display

- Layer Turbulence Maximum (LTM) product request displays LRM-AP Removed (APR) product, but inaccurately
- Layer Turbulence Average (LTA) product does not display
- No ability to select storms from attribute tables
- Narrowband communications speed limited to 9600 bps

**Build 10.0 PUP connected to Build 9.0 RPG**

- TVS/ETVS alerts do not work properly and should be avoided
- Hybrid Scan Reflectivity (HSR) product is not available
- LRM-AP Removed (APR) product is not available. Requests for APR actually display a Layer Turbulence Maximum (LTM) product.
- Layer Turbulence Average (LTA) product does not display
- Build 9 attribute tables displayed
- Ability to select storms from attribute table may not work.
- Narrowband communications speed limited to 9600 bps
- 31 product RPS list accepted, but possible loadshed problems due to comms speed of 9600 bps

# New Algorithms / Products

## New Tornado Detection Algorithm (TDA) / TVS Product

**Introduction**

Build 10 introduces a new Tornado Detection Algorithm (TDA) which is replacing the current Tornadic Vortex Signature (TVS) Detection Algorithm. Although the algorithm name is changing from TVS to TDA, the WSR-88D product will continue to be called Tornadic Vortex Signature (mnemonic TVS, ID# 61).

The Build 9 TVS algorithm is not very robust, and was designed to be a place holder until a better algorithm could be put in place. As a result, performance of the current TVS algorithm is poor, with a low probability of detection, limited adaptable parameters, no discrimination between tornadic and non-tornadic shears, and no requirement for shear to be gate-to-gate. Once in a great while, when the TVS algorithm triggered, it mostly confirmed tornadic events that had already occurred.

The Tornado Detection Algorithm (TDA) was developed at the **National Severe Storms Laboratory (NSSL)** and is designed to detect significant shear regions in the atmosphere. The TDA uses multiple velocity thresholds to locate shear regions, and classifies these regions according to altitude and strength. The WSR-88D TVS product in Build 10 displays more operationally pertinent information, and a new graphic symbol. Performance of the TDA is better than TVS, with a higher probability of detection, many adaptable parameters, some discrimination between tornadic and non-tornadic shear, and a requirement for gate-to-

gate shear. TDA can provide positive lead times for storms that become tornadic.

## Build 9 TVS Detection Algorithm - A Review

The Build 9 TVS and mesocyclone algorithms work together, and in fact, the bulk of the velocity analysis for TVS is actually performed by the mesocyclone algorithm. The mesocyclone algorithm processes velocity data and identifies 3-D circulations. If a mesocyclone is found, the TVS algorithm performs shear calculations within that circulation to determine if a Tornadic Vortex Signature also exists. ***In Build 9 software, a TVS cannot exist without an algorithm-identified mesocyclone.***

The ***mesocyclone*** algorithm builds circulations in a multi-step process. First, a pattern vector is identified by searching for a series of azimuthally adjacent range bins with increasing Doppler velocity on an elevation slice (see Fig. 1). (All algorithm

**Pattern Vector**
**(A run of increasing velocities)**

| RANGE | rad #1 | rad#2 | rad#3 | rad#4 | rad#5 | rad#6 | rad#7 |
|---|---|---|---|---|---|---|---|
| **33.00km** | -7 | -10 | -10 | -7 | 1 | 2 | 1 |
| **32.75km** | -10 | -15 | -13 | -11 | 4 | 3 | 0 |
| **32.50km** | -4 | -11 | -14 | -18 | 12 | 22 | 13 |
| **32.25km** | -11 | -19 | -22 | 13 | 18 | 11 | -1 |
| **32.00km** | -4 | -9 | -19 | 3 | 18 | 17 | 12 |
| **31.75km** | -10 | -14 | -22 | 1 | 21 | 9 | 9 |
| **31.50km** | -10 | -25 | -19 | -6 | 6 | 2 | 1 |
| **31.25km** | -7 | -3 | -5 | -6 | 7 | 13 | 10 |
| **31.00km** | -1 | 2 | 1 | -3 | -4 | -4 | -6 |

**RDA**

**Figure 1.** Runs of increasing velocity are highlighted in blue. Note the relative position of the RDA at the bottom of the table.

processing occurs clockwise, or with increasing azimuth, which implies that only cyclonic features are detected). Pattern vector velocity values must

satisfy momentum and shear criteria. If these criteria are not met, the pattern vector is discarded (see Fig. 2).

**Pattern Vector**
**(A run of increasing velocities)**

| RADIAL | rad #1 | rad#2 | rad#3 | rad#4 | rad#5 | rad#6 | rad#7 |
|---|---|---|---|---|---|---|---|
| 33.00km | -7 | -10 | -10 | -7 | 1 | 2 | 1 |
| 32.75km | -10 | -15 | -13 | -11 | 4 | 3 | 0 |
| 32.50km | -4 | -11 | -14 | -18 | 12 | 22 | 13 |
| 32.25km | -11 | -19 | -22 | 13 | 18 | 11 | -1 |
| 32.00km | -4 | -9 | -19 | 3 | 18 | 17 | 12 |
| 31.75km | -10 | -14 | -22 | 1 | 21 | 9 | 9 |
| 31.50km | -10 | -25 | -19 | -6 | 6 | 2 | 1 |
| 31.25km | -7 | -3 | -5 | -6 | 7 | 13 | 10 |
| 31.00km | -1 | 2 | 1 | -3 | -4 | -4 | -6 |

**RDA**

**Figure 2.** Pattern vectors in green did not satisfy momentum and shear criteria.

Next, pattern vectors in close proximity to one another are combined to form 2-D features. Whether or not pattern vectors become associated with the same 2-D feature depends on their azimuthal and radial distance from one another. The RPG adaptable parameter Threshold Pattern Vector, TPV, determines the minimum number of pattern vectors required (default 10) for a 2-D feature to be identified (see Fig. 3).

Finally, 2-D features are vertically correlated to form 3-D circulations. Ideally, all 2-D features in the same 3-D circulation lie on adjacent elevation angles. However, the software permits one missing elevation angle between features to allow for dealiasing and range folding problems (see Fig. 4). Circulations are labeled as Mesocyclones when the circulation meets an aspect ratio of a given length to width (adaptable parameter). Oth-

**2-D Feature**
**(Only if number of pattern vectors exceed TPV)**

| RADIAL | rad #1 | rad#2 | rad#3 | rad#4 | rad#5 | rad#6 | rad#7 |
|---|---|---|---|---|---|---|---|
| 33.00km | -7 | -10 | -10 | -7 | 1 | 2 | 1 |
| 32.75km | -10 | -15 | -13 | -11 | 4 | 3 | 0 |
| 32.50km | -4 | -11 | -14 | -18 | 12 | 22 | 13 |
| 32.25km | -11 | -19 | -22 | 13 | 18 | 11 | -1 |
| 32.00km | -4 | -9 | -19 | 3 | 18 | 17 | 12 |
| 31.75km | -10 | -14 | -22 | 1 | 21 | 9 | 9 |
| 31.50km | -10 | -25 | -19 | -6 | 6 | 2 | 1 |
| 31.25km | -7 | -3 | -5 | -6 | 7 | 13 | 10 |
| 31.00km | -1 | 2 | 1 | -3 | -4 | -4 | -6 |

**RDA**

**Figure 3.** 2-D feature is outlined.

erwise, circulations are labeled as 3-D Correlated Shear.

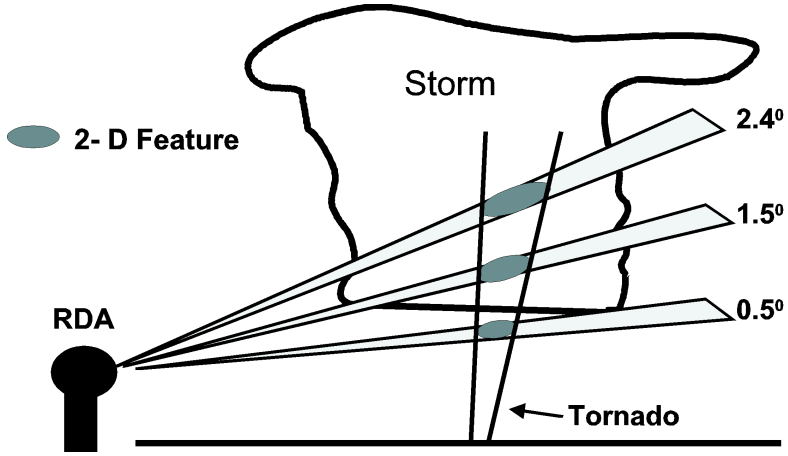


**Figure 4.** Vertically correlated 2-D features.

The Build 9 ***TVS*** algorithm is initiated once the mesocyclone algorithm detects a mesocyclone. For each 2-D feature within the mesocyclone, the area is expanded by the amount specified by PCT (search percentage, default 5%), then searched for ***minimum-maximum velocities***, and a shear value is calculated (see Fig. 5). If a threshold shear value is reached on at least 2 elevations within the mesocyclone, a TVS is declared. ***Note***

***that TVS shear need not be gate-to-gate.*** The RPG adaptable parameter TVS Threshold Shear, TTS, allows the operator to control algorithm performance by changing TVS shear criteria.

**2-D Feature Velocity Extremes**
**(Can be radially / azimuthally separated)**

| RADIAL | rad #1 | rad#2 | rad#3 | rad#4 | rad#5 | rad#6 | rad#7 |
|---|---|---|---|---|---|---|---|
| 33.00km | -7 | -10 | -10 | -7 | 1 | 2 | 1 |
| 32.75km | -10 | -15 | -13 | -11 | 4 | 3 | 0 |
| 32.50km | -4 | -11 | -14 | -18 | 12 | 22 | 13 |
| 32.25km | -11 | -19 | -22 | 13 | 18 | 11 | -1 |
| 32.00km | -4 | -9 | -19 | 3 | 18 | 17 | 12 |
| 31.75km | -10 | -14 | -22 | 1 | 21 | 9 | 9 |
| 31.50km | -10 | -25 | -19 | -6 | 6 | 2 | 1 |
| 31.25km | -7 | -3 | -5 | -6 | 7 | 13 | 10 |
| 31.00km | -1 | 2 | 1 | -3 | -4 | -4 | -6 |

**RDA**

**Figure 5.** Red and green values used in TVS shear calculation.

## Build 10 Tornado Detection Algorithm

In Build 10, the Mesocyclone and Tornado Detection algorithms process data separately. This means that ***an algorithm-identified mesocyclone need not exist for a TVS or Elevated TVS (ETVS) to be identified.*** The TDA is modeled after the SCIT algorithm and uses a three step process to identify circulations.

First, 1-D pattern vectors are identified on each elevation slice. In TDA, a pattern vector is a region of gate-to-gate shear, which means the velocity difference is calculated between range bins ***located on adjacent azimuths*** at the same range. A minimum shear value is required for a pattern vector to be identified (see Fig. 6). The TDA searches only for patterns of velocity indicat-

ing cyclonic rotation. It ***does not*** detect an anticyclonically rotating tornadic signature.

**1-D Pattern Vector**
**(Shear Segment)**

| RADIAL | rad #1 | rad#2 | rad#3 | rad#4 | rad#5 | rad#6 | rad#7 |
|---|---|---|---|---|---|---|---|
| **33.00km** | -7 | -10 | -10 | -7 | 1 | 2 | 1 |
| **32.75km** | -10 | -15 | -13 | -11 | 4 | 3 | 0 |
| **32.50km** | -4 | -11 | -14 | -18 | 12 | 22 | 13 |
| **32.25km** | -11 | -19 | -22 | 13 | 18 | 11 | -1 |
| **32.00km** | -4 | -9 | -19 | 3 | 18 | 17 | 12 |
| **31.75km** | -10 | -14 | -22 | 1 | 21 | 9 | 9 |
| **31.50km** | -10 | -25 | -19 | -6 | 6 | 2 | 1 |
| **31.25km** | -7 | -3 | -5 | -6 | 7 | 13 | 10 |
| **31.00km** | -1 | 2 | 1 | -3 | -4 | -4 | -6 |

**RDA**

**Figure 6.** TDA pattern vectors shown in pink. For reference, mesocyclone pattern vectors are shown in blue.

Next, 2-D features are created by combining the 1-D pattern vectors (see Fig. 7). At least three pattern vectors (default) are needed to declare a 2-D feature. TDA uses six velocity difference thresholds to identify pattern vectors. This technique allows the algorithm to isolate core circulations which may be embedded within regions of long

**2-D Features**
**(Combine 1-D Pattern Vectors and Trim)**

| RANGE | rad #1 | rad#2 | rad#3 | rad#4 | rad#5 | rad#6 | rad#7 |
|---|---|---|---|---|---|---|---|
| **33.00km** | -7 | -10 | -10 | -7 | 1 | 2 | 1 |
| **32.75km** | -10 | -15 | -13 | -11 | 4 | 3 | 0 |
| **32.50km** | -4 | -11 | -14 | -18 | 12 | 22 | 13 |
| **32.25km** | -11 | -19 | -22 | 13 | 18 | 11 | -1 |
| **32.00km** | -4 | -9 | -19 | 3 | 18 | 17 | 12 |
| **31.75km** | -10 | -14 | -22 | 1 | 21 | 9 | 9 |
| **31.50km** | -10 | -25 | -19 | -6 | 6 | 2 | 1 |
| **31.25km** | -7 | -3 | -5 | -6 | 7 | 13 | 10 |
| **31.00km** | -1 | 2 | 1 | -3 | -4 | -4 | -6 |

**RDA**

**Figure 7.** TDA 2-D feature outlined in black.

azimuthal shear. An example would be a radially oriented gust front or squall line. In Figure 8, a long segment of shear exceeding 15 m/s has embedded within it a smaller segment of shear greater than 20 m/s, and still smaller segments of shear greater than 25 m/s. If a 2-D feature passes a symmetry test (length to width ratio within a specified limit), it is declared a 2-D circulation.

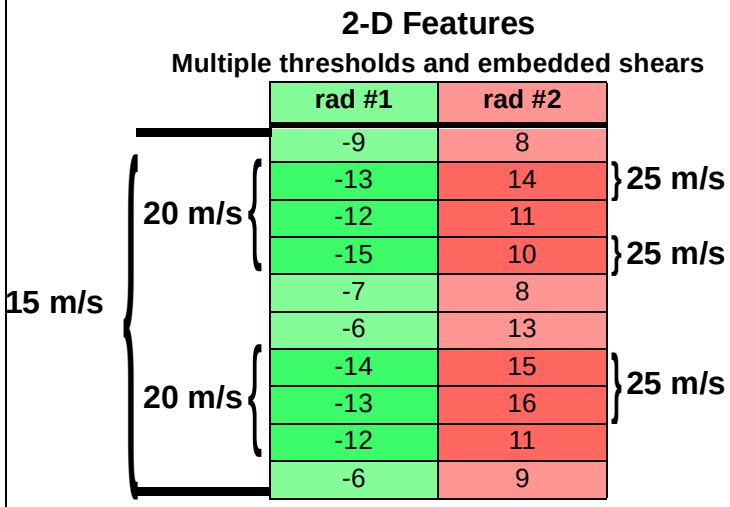


**Figure 8.** Multiple velocity thresholds used to identify stronger shear embedded within weaker shear.

Finally, 3-D features are created by vertically correlating the 2-D circulations identified at each elevation (see Fig. 9). Processing begins by correlating the strongest 2-D circulations first, then moving to progressively weaker circulations. If a feature contains at least three vertically correlated 2-D circulations, it is declared a 3-D circulation, and identified as either a TVS or an ETVS. Ideally, there will be no gaps in elevation angles between the vertically correlated 2-D circulations. However, a one elevation angle gap is permitted to account for base data problems such as range folding and velocity dealiasing failures.

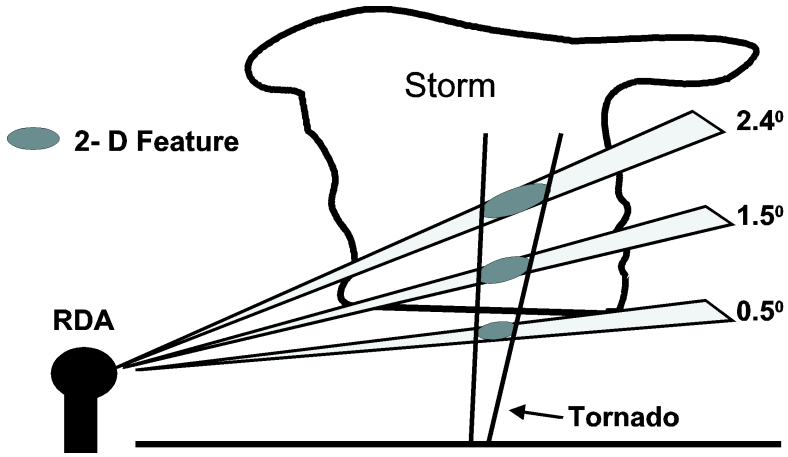


**Figure 9.** Vertically correlated 2-D circulations.

## TDA vs. TVS Shear Calculation

A comparison of Build 10 TDA and Build 9 TVS indicates one weakness of the TVS algorithm. In Build 9, intense shear may exist gate-to-gate, but if larger values of inbound and outbound velocity exist elsewhere in the feature, shear will be calculated using those velocity values, and not the gate-to-gate velocity values (see Fig. 10). Recall that shear is defined as the velocity difference divided by the distance between the velocity values. In this case, the large separation of the strongest velocity values results in the TVS algorithm having a shear about 1/3 as large as the gate-to-gate TDA shear, even though the velocity values used in calculating TVS shear are larger.

Some tornadoes have been observed in circulations in which the gate-to-gate shear was weak, but a 3-D velocity feature caused the Build 9 TVS algorithm to trigger. This resulted in the TVS algorithm outperforming the Build 10 TDA. This apparently occurs only rarely.

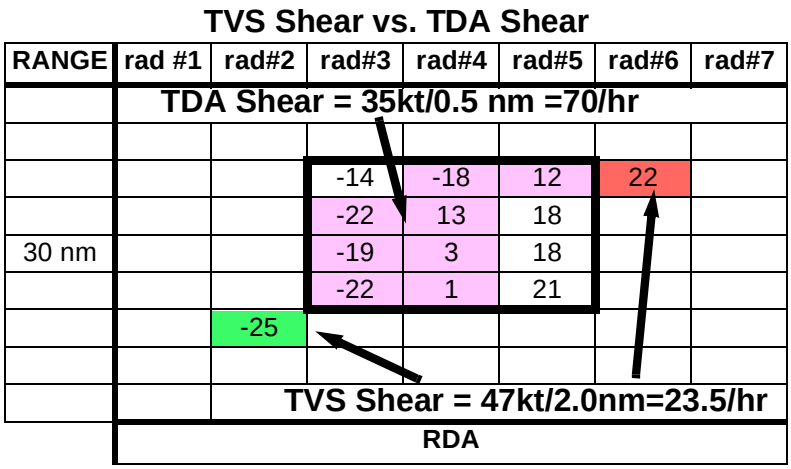


**Figure 10.** Calculation of TVS shear vs. TDA shear.

## Definitions and Symbology

The Build 10 Tornado Detection Algorithm conducts a more thorough analysis of the velocity data as compared to Build 9 TVS Detection Algorithm. This gives operators more pertinent information about the structure and strength of possible tornadic circulations. In addition to a new TVS definition, an Elevated TVS definition has been added.

### TVS

A Tornadic Vortex Signature, TVS, is defined as a 3-D circulation with a base located on the 0.5º slice ***or*** below 600 meters ARL (above radar level). The depth of the circulation must be at least 1.5 km. Additionally, the maximum delta velocity anywhere in the circulation must be at least 36 m/s, or at least 25 m/s at the base of the circulation. The TVS symbol is displayed on the graphic product and overlay as a red, filled, inverted triangle, slightly larger than the Build 9 symbol. TVS symbols are placed at the azimuth and range of the lowest 2-D feature.

### ETVS

An Elevated Tornadic Vortex Signature, Elevated TVS or ETVS, is defined as a 3-D circulation with a base above the 0.5º slice ***and*** above 600 meters ARL. The depth of the circulation must be at least

1.5 km. Additionally, the delta velocity at the base of the circulation must be at least 25 m/s. The ETVS symbol is displayed on the TVS overlay and the TVS graphic product as a red, open, inverted triangle as shown in Figure 11, and is placed at the azimuth and range of the lowest 2-D feature.

The default values listed above for depth, delta velocity at the base of the circulation, maximum delta velocity anywhere in the circulation, and height above radar are only ***some*** of the TDA adaptable parameters.

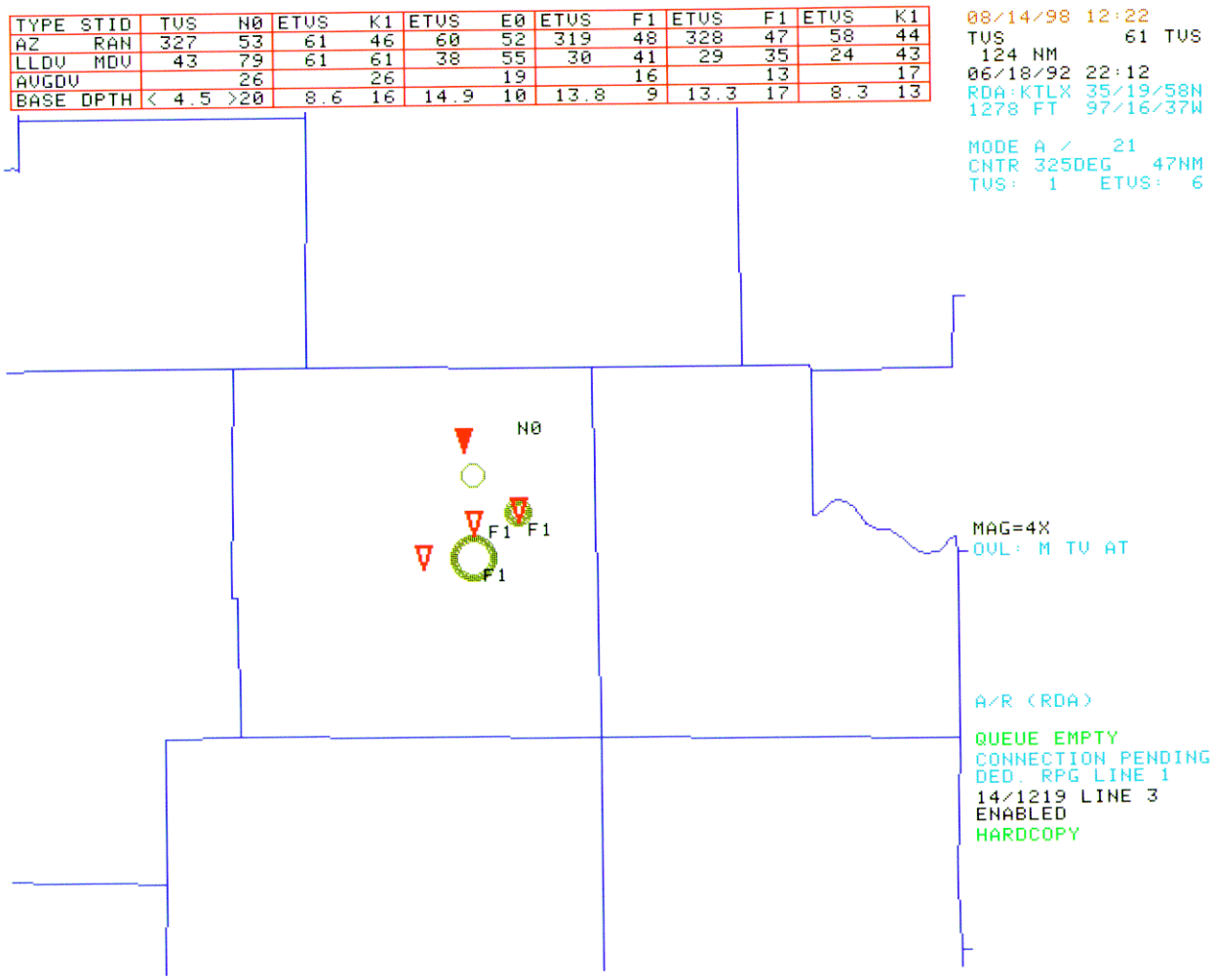


**Figure 11.** Example of the Build 10 TVS graphic product.

Note that an Elevated TVS may possess a larger value of maximum shear somewhere in the storm column as compared to a TVS, but if there is no circulation on the 0.5º slice or below 600 meters, it cannot be defined as a TVS, despite possessing the higher shear.

**Graphic Attribute Table Definitions**

The TVS attribute table has more operationally useful information displayed in Build 10. Some new definitions and abbreviations are:

- **LLDV**: Low-Level Delta Velocity, in knots (Greatest velocity difference of lowest 2-D circulation)
- **MDV**: Maximum Delta Velocity, in knots (Greatest velocity difference of any 2-D circulation)
- **AVGDV**: Average Delta Velocity, in knots (Average weighted velocity difference of all 2-D circulations)
- **BASE**: Lowest altitude of the 3-D circulation, in Kft (Altitude of the lowest 2-D circulation)
- **DPTH**: Depth of the 3-D circulation, in Kft (Height difference between the lowest and highest 2-D circulation)

If a circulation exists at either 0.5º or 19.5º, then the depth of the circulation (DPTH) is estimated, and a > (greater than) symbol will be displayed with the stated depth. Similarly, if the circulation exists at 0.5º, the base (BASE) of the circulation is estimated, and a < (less than) symbol will be used with the stated base altitude (see Fig. 12).

**TVS Alphanumeric Product**

The TVS alphanumeric product generated by the TDA gives the same information as the TVS attribute table. It also gives the height of the Maximum Delta Velocity (MXDV/Hgt) and Maximum Shear and the height (MXSHR/Hgt) at which this

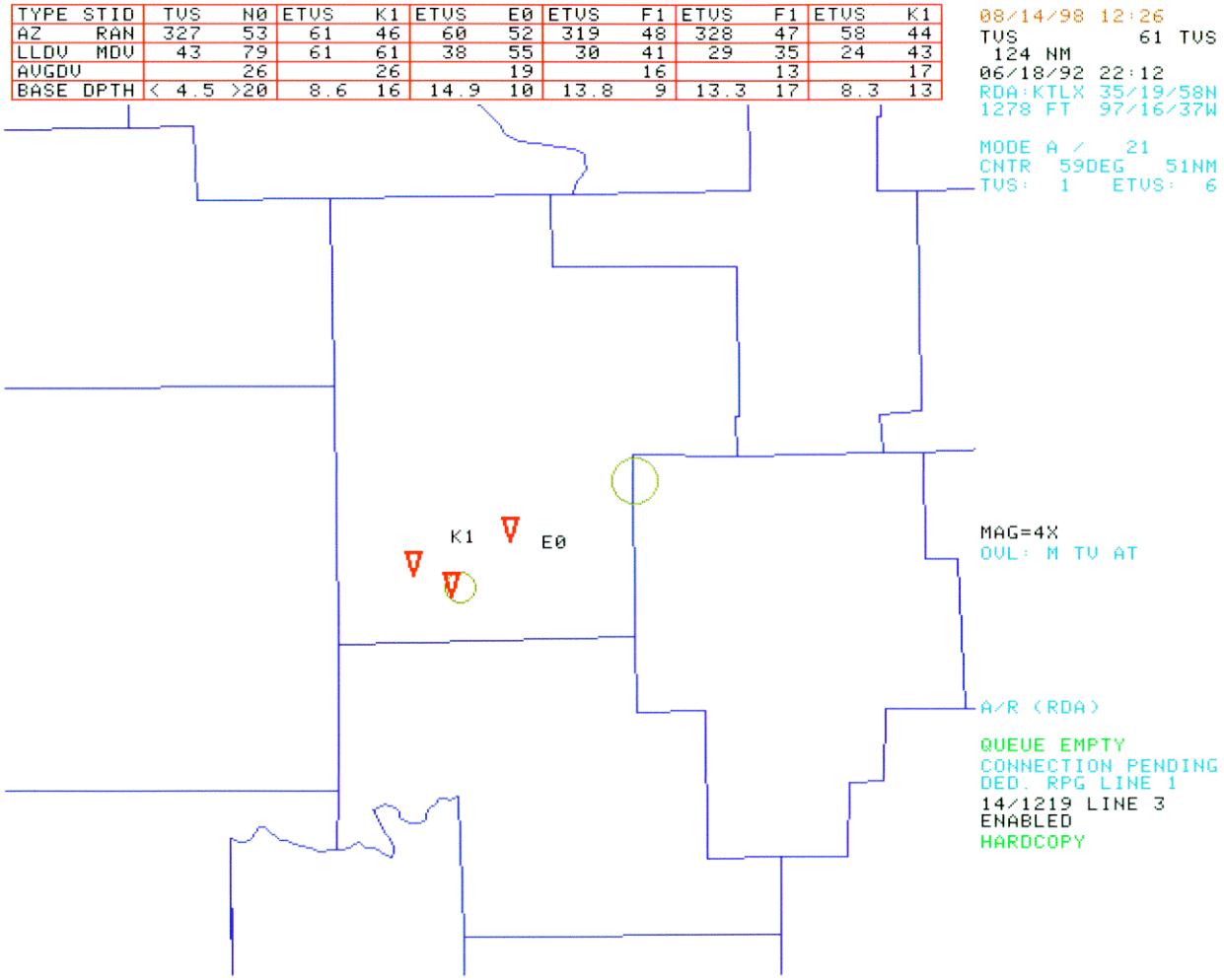


**Figure 12.** TVS product with attribute table.

value is found (in thousands of feet ARL). Figure 13 shows a Build 10 TVS alphanumeric product.

Since the Mesocyclone and Tornado Detection algorithms work independently of one another in Build 10, the TVS column has been dropped from the Mesocyclone alphanumeric product. This change is occurring not because the Mesocyclone algorithm has changed, but because the TVS algorithm (closely tied to Mesocyclone) has been changed to TDA (independent of Mesocyclone).

```
                  ALPHA PRODUCT 61 (TVS  KABR 21:52  05/31/96)     Page 1 of 2
COMMAND:  D,A,
FEEDBACK: EXECUTED - D,A,TVS


                            Tornado Vortex Signature
      Radar Id 309   Date/Time  05:31:96/21:52:32   Number of TVS/ETVS    1/  2

 Feat  Storm   AZ/RAN  AVGDV  LLDV  MXDV/Hgt   Depth    Base/Top   MXSHR/Hgt
 Type    ID   (deg,nm)  (kt)  (kt)  (kt,kft)   (kft)     (kft)     (E-3/s,kft)

  TVS    Q1   251/ 18    33    52    52/ 1.1   >23.7  < 1.1/ 24.8    47/ 1.1
 ETVS    W0   306/ 23    32    86    86/ 8.5    15.2    8.5/ 23.6    61/ 8.5
 ETVS    W0   303/ 22    31    66    66/ 5.8     7.9    5.8/ 13.7    49/ 5.8
```

**Figure 13.** TVS alphanumeric product.

## Combined Attribute Table

The information from the Mesocyclone and Tornado Detection algorithms is output to the Combined Attribute Table (CAT) as well as other graphic and alphanumeric products. In Build 9, the entries in the CAT for both the TVS and MESO columns were either YES or NO. In Build 10, this table will display types of circulations identified by the algorithms (see Fig. 14). In the TVS column, the Combined Attribute Table will now state one of the following:

| | |
|---|---|
| TVS | Tornadic Vortex Signature identified |
| ETVS | Elevated Tornadic Vortex Signature identified |
| NONE | No TVS or ETVS identified |

In the MESO column, the Combined Attribute Table will now state one of the following:

| | |
|---|---|
| MESO | Mesocyclone identified |
| 3DCO | 3-D Correlated Shear identified |
| UNCO | Uncorrelated Shear (2-D) identified |
| NONE | No Meso, 3-D shear or 2-D shear identified |

Recall that on the Mesocyclone graphic product and overlay, there is no symbol for 2-D (Uncorrelated) Shear.

The CAT is distributed to NIDS vendors, therefore TVS/ETVS locations may be displayed by the media.

## TDA Adaptable Parameter Sets

The Tornado Detection Algorithm contains 30 adaptable parameters as compared to only two for the TVS Detection Algorithm. The default values for TDA were derived from analyzing algorithm performance while using a large, geographically diverse data set. The OSF recognizes that the

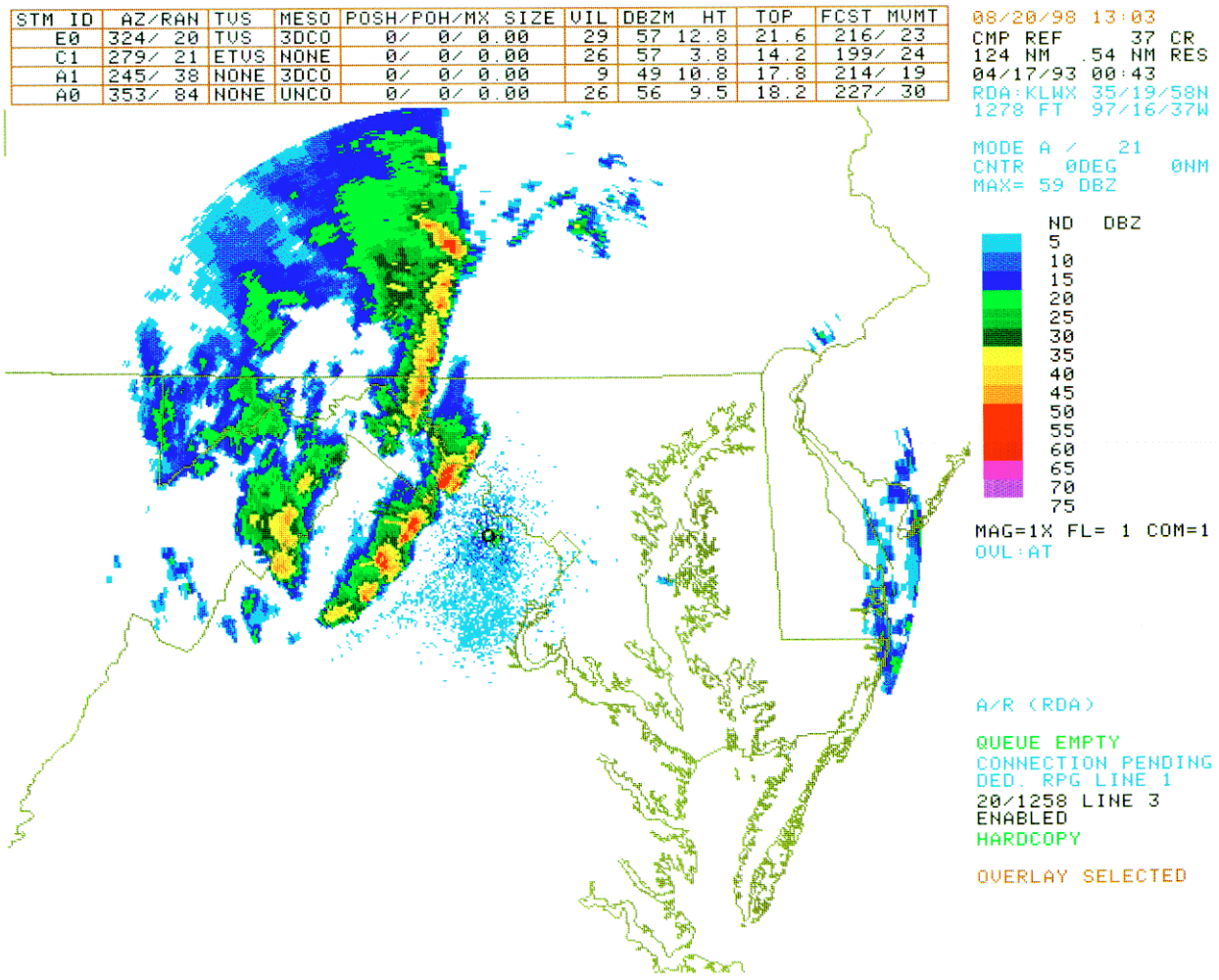


**Figure 14.** Composite Reflectivity with Combined Attribute Table.

default values assigned to the TDA will not work well in all regions of the country and for all weather situations. Therefore, the OSF has delegated authority for changing some of these values to the Unit Radar Committee (URC) level in the form of parameter sets. Currently, there are four parameter sets from which to choose:

1. Default
2. Minimized (Conservative)
3. Squall Line
4. Tropical

The ***default*** adaptable parameter set optimizes algorithm performance for all types of storm events. When compared to the Build 9 TVS algorithm, TDA with the ***default*** parameters produces a much higher POD, meaning that a greater number of tornadic events will be detected (see Fig. 15). The ***default*** settings also result in a much

**TVS/TDA Performance**

| | TVS | TDA (Def) | TDA (Min) |
|---|---|---|---|
| POD | 7 | 46 | <5 |
| FAR | 8 | 39 | <5 |
| CSI | 7 | 36 | <5 |

**Figure 15.** TVS/TDA Performance (ETVS not included.)

higher FAR, meaning that a significant number of TVS/ETVS symbols will be displayed for events which are ultimately non-tornadic.

The ***minimized*** (conservative) adaptable parameter set results in the TDA performing much like the Build 9 TVS algorithm. The ***minimized*** parameter set gives a POD of tornadic shear close to 5%, meaning that many tornadic circulations will go

undetected. The ***minimized*** setting produces a FAR which is also close to 5%, meaning that if a circulation is detected it is likely significant.

Studies of TDA performance for squall line and tropical events suggest that neither the default nor the minimized parameter result in the best algorithm output. The ***Squall Line*** and ***Tropical*** parameter sets were developed to enhance performance during these types of weather situations. Performance scores were not finalized when this document went to print, but will be available when Build 10 software is released.

It must be stressed that no matter which parameter set is selected, only the OSF specified values are to be used. The ***RPG Adaptable Parameters Handbook*** lists the valid settings for each parameter set in section *6.15 - Tornado Detection Algorithm*.

Currently, each adaptable parameter set created by the OSF consists of only three editable parameters at the UCP. The ***Minimum 3-D Feature Low-Level Delta Velocity*** is the velocity threshold which must be exceeded in the lowest 2-D feature for a circulation to be declared either a TVS or an ETVS. The ***Minimum TVS Delta Velocity*** is the velocity threshold which must be exceeded at any elevation for a circulation to be declared a TVS. The ***Minimum 3D Feature Depth*** is the minimum depth required to declare a TVS or an ETVS (see Fig. 16 on page 20).

## TDA Adaptable Parameters Under URC Level of Change Authority (LOCA)

Three additional TDA parameters are under the URC LOCA. The ***Minimum Reflectivity*** is the lowest value of reflectivity required for a range bin to be used in a pattern vector. Unit Radar Committees have the authority to change this value between 0 and +20 dBZ. The default value is set to 0 dBZ. Lower values of reflectivity imply that TDA will process more data, increasing CPU usage. Larger values imply that some circulations well outside the storm core may not be included for processing by TDA.

The ***Maximum Pattern Vector Range*** is the maximum range at which pattern vectors are identified. Unit Radar Committees may adjust this parameter to between 100 and 150 km. The default value is set to 100 km (see Fig. 17).

The ***Maximum Number of Elevated TVSs*** parameter controls how many ETVSs the algorithm can process per volume scan. The default

```
                                    TVS                          PAGE 2 OF 3

COMMAND: AD,*****,M,*****,TV,
FEEDBACK:                                                      OPER A/

      (M)odify  (E)nd  (C)ancel

DESCRIPTION                          RANGE             VALUES    UNITS
-------------------------------------------------------------------------
2D VECTOR RADIAL DISTANCE          0.0 - 3.0             0.5     KM
2D VECTOR AZIMUTHAL DISTANCE       0.0 - 4.0             1.5     DEG
2D FEATURE ASPECT RATIO            1.0 - 10.0            4.0     KM/KM
CIRCULATION RADIUS   #1            0.0 - 10.0            2.5     KM
CIRCULATION RADIUS   #2            0.0 - 10.0            4.0     KM
CIRCULATION RADIUS RANGE             1 - 230              80     KM
MAXIMUM # 2D FEATURES              600 - 800             600     -
MIN # 2D FEATURES/3D FEATURE         1 - 10                3     -
MINIMUM 3D FEATURE DEPTH           0.0 - 5.0             1.5     KM
MIN 3D FEAT LOW-LVL DELTA VEL        0 - 100              25     M/S
MINIMUM TVS DELTA VELOCITY           0 - 100              36     M/S
MAXIMUM 3 3D FEATURES               30 - 50               35     -
```

**Figure 16.** TVS Adaptable Parameters Edit Screen

Build 10 value for this adaptable parameter is set to zero, which means that ETVS features will not be identified unless this parameter is changed. (Allowable values range from 0 to 25, see Figure 18). The OSF has delegated the authority to change the Maximum Number of Elevated TVSs to the Unit Radar Committee level.

```
                                   TVS                          PAGE 1 OF 3

COMMAND: AD,*****,M,*****,TV,
FEEDBACK:                                                        OPER A/

      (M)odify  (E)nd  (C)ancel

DESCRIPTION                         RANGE             VALUES    UNITS
-------------------------------------------------------------------------
MINIMUM REFLECTIVITY THRESHOLD     -20 - 20             0       DBZ
VECTOR VELOCITY DIFFERENCE          10 - 75            11       M/S
MAXIMUM PATTERN VECTOR RANGE         0 - 230          100       KM
MAXIMUM PATTERN VECTOR HEIGHT      0.0 - 15.0        10.0       KM
MAXIMUM # OF PATTERN VECTORS      1500 - 3000        2500       -
DIFFERENTIAL VELOCITY #1            10 - 75            11       M/S
DIFFERENTIAL VELOCITY #2            15 - 80            15       M/S
DIFFERENTIAL VELOCITY #3            20 - 85            20       M/S
DIFFERENTIAL VELOCITY #4            25 - 90            25       M/S
DIFFERENTIAL VELOCITY #5            30 - 95            30       M/S
DIFFERENTIAL VELOCITY #6            35 - 100           35       M/S
MINIMUM # VECTORS/2D FEATURE         1 - 10             3       -
```

**Figure 17.** TVS Adaptable Parameters Edit Screen

```
                                   TVS                          PAGE 3 OF 3

COMMAND: AD,*****,M,*****,TV,
FEEDBACK:                                                        OPER A/

      (M)odify  (E)nd  (C)ancel

DESCRIPTION                         RANGE             VALUES    UNITS
-------------------------------------------------------------------------
MAXIMUM # OF TVSs                   15 - 25            15       -
MAXIMUM # OF ELEVATED TVSs           0 - 25             0       -
MINIMUM TVS BASE HEIGHT            0.0 - 10.0         0.6       KM
MINIMUM TVS BASE ELEVATION         0.0 - 10.0         1.0       DEG
AVERAGE DELTA VELOCITY HEIGHT      0.0 - 10.0         3.0       KM
MAXIMUM STORM ASSOCIATION DIST     0.0 - 20.0        20.0       KM
```

**Figure 18.** TVS Adaptable Parameter Edit Screen.

Setting ***Maximum Number of Elevated TVSs*** too low may result in significant circulations aloft going undetected, potentially diminishing lead time during future tornadic events. Setting this number high may result in an excessive number of non-tornadic circulations being detected. Users should consider that the output from the TDA is also sent to NIDS vendors via the Combined Attribute Table. The NIDS vendors provide this data to the media as value-added products. The numerical value used for this adaptable parameter not only controls the ETVS detections seen internally on AWIPS or at the PUP, but also how many ETVSs the media will receive.

**Elevated TVS Display Toggle**

Depending on which adaptable parameter settings are invoked, it is possible to have a situation when the display becomes cluttered with Elevated TVS symbols, making product interpretation difficult. For this reason, PUP/AWIPS operators have been given control over whether or not ETVS symbols are displayed on the TVS graphic product and overlay.

At the PUP Applications Terminal, the ***Extended Adaptation Data Menu*** contains a newly modified edit screen called ***SCIT HDA and TVS Display Parameters*** as shown in Figures 19 and 20. Operators enter “Y” to enable or “N” to disable the display of Elevated TVSs. The default setting has ETVS symbols turned ***off*** (Note, however, that Figure 20 shows ETVS Symbols turned ***on***).

```
                          EXTENDED ADAPTATION DATA MENU
COMMAND:  AD,*****,
FEEDBACK:

Enter command.

(P)RECEDENCE OF OVERLAYS *
(C)OLORS, (P)RODUCT, <PROD-ID#>, (C)OLOR SCALE, <screen> **
                               , (G)RAY SCALE,  <screen> **
                               , (H)ARDCOPY *
       , (S)AVE COLOR SELECTIONS
       , (C)ANCEL COLOR SELECTION MODE
(RCM) PARAMETERS *
(D)IAL IN OTHER USER LIST *
(R)PG LIST *
(N)ARROWBAND LINE DEFINITIONS *
(S)CIT HDA and TVS Display Parameters *
(PASS)WORD CHANGE, <New Password>
NUMERICALLY EDITABLE DATA
 *Footnote:  Enters edit screen at this point.
**Footnote:  Enters color selection mode at this point.
```

**Figure 19.** PUP Extended Adaptation Data Menu.

```
                SCIT HDA AND TVS DISPLAY PARAMETERS EDIT SCREEN
COMMAND:  AD,*****,S
FEEDBACK:

Enter the display parameters and press RETURN. Changes take effect immediately.

  SCIT        Number of cells to display (0 to 100): 20
              Display past positions? (Y or N)     :   Y
              Display forecast positions? (Y or N) :   Y

  HDA         Probability of Hail
                   Minimum display threshold (10% to 100%, or D*): 30  %
                   Symbol fill-in threshold (10% to 100%)        : 50  %

              Probability of Severe Hail
                   Minimum display threshold (10% to 100%, or D*): 30  %
                   Symbol fill-in thresold (10% to 100%)         : 50  %

  TVS       Display Elevated Tornadic Vortex Signatures? (Y or N):  Y

        *Entering the letter D here will disable the display of this symbol.
```

**Figure 20.** PUP TVS Display Parameters Edit Screen.

This toggle does ***not*** affect the TVS attribute table or the TVS alphanumeric product. It is a PUP graphic display function only. Changing the ETVS toggle affects all subsequent TVS products and overlays displayed at the PUP (see Fig. 21). ***If the PUP display of ETVS symbols is toggled to "off", a situation could arise where the local media are displaying ETVSs, but the PUP is not displaying this information.***

**Strengths**

Velocity processing is more sophisticated with TDA. The algorithm searches for gate-to-gate shear, which is more closely related to tornadic circulations as compared to strong shear that is not

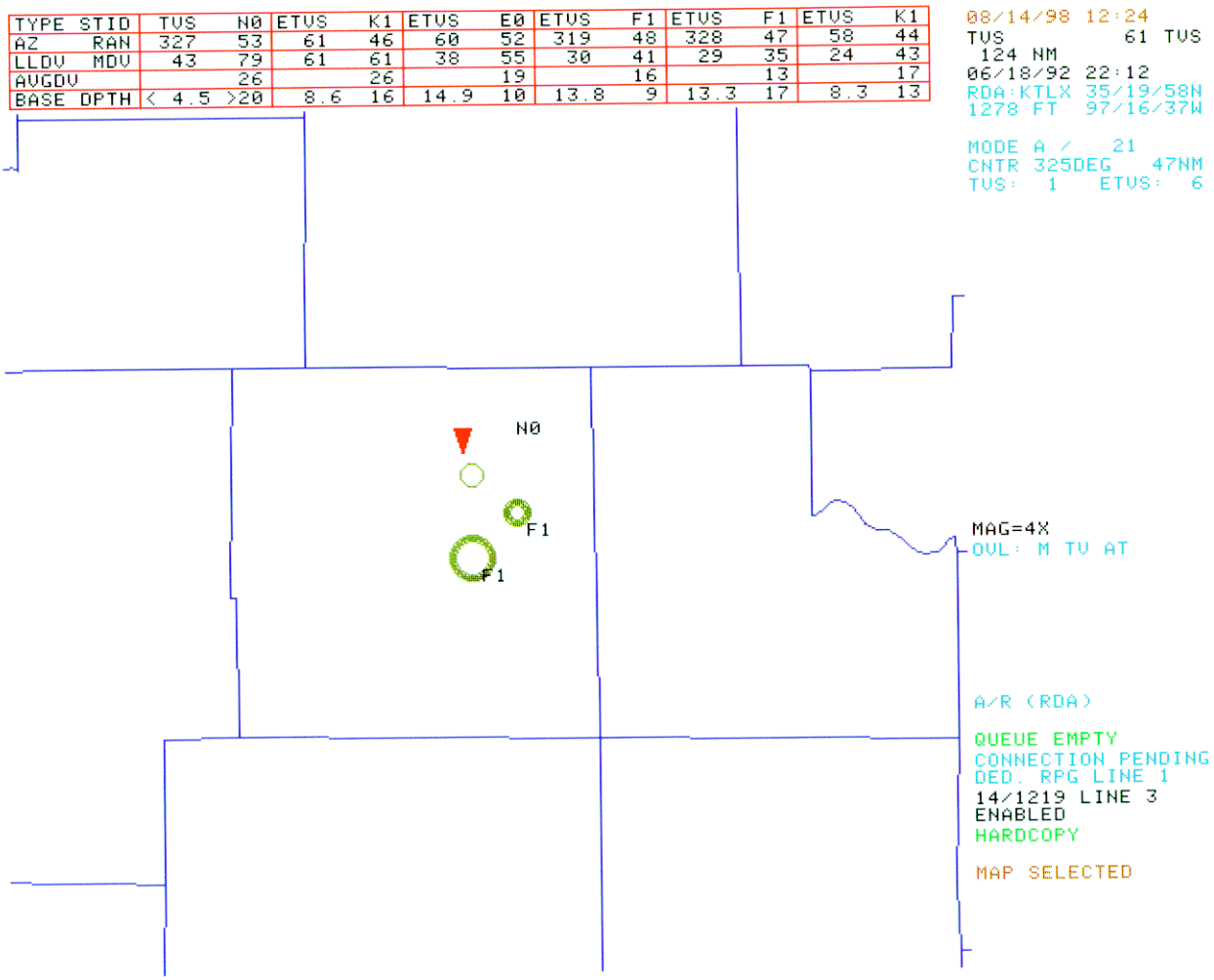


**Figure 21.** TVS product with ETVS symbols disabled.

gate-to-gate. Multiple velocity-difference thresholds make it possible to isolate smaller regions of shear within broader regions. The algorithm searches ***all*** velocity pairs possessing a reflectivity and velocity above certain thresholds. The Build 9 TVS algorithm only searches for shear within algorithm-identified mesocyclones.

The output from TDA can be more useful in an operational environment. A distinction is made between different types of shears (TVS vs. ETVS, delta velocity calculations), and more information is provided about the base and depth of circulations. The algorithm, through a greater number of adaptable parameters, allows fine-tuning of algorithm performance, resulting in a higher probability of detecting operationally important shear regions.

**Limitations**

Adaptable parameters need more research. Parameters which work well in one type of meteorological setting may not be as effective in other situations. Use of this output may require a change in operational philosophy. Algorithm performance using the ***default*** settings results in a higher False Alarm Ratio. Operators are accustomed to a very low False Alarm Ratio with TVS, which implies that any detections are to be taken seriously. A higher FAR with TDA may result in over-warning, or desensitizing forecasters. In addition, little research has been done to date relating the occurrence of tornadoes to Elevated TVSs. Forecasters should use ETVS output with caution until they develop a better understanding of its utility.

**Velocity Dealiasing Algorithm Changes to Support TDA**

The Build 10 Velocity Dealiasing Algorithm has been changed to eliminate data dropouts which sometimes occur in high shear regions. The algorithm restores velocity data previously discarded by the Build 9 algorithm. ***Operators can no***

***longer use the existence of data dropouts as indicators of high shear regions.*** Also, only very rarely will velocity dealiasing errors align vertically on three elevation scans and cause a TVS false alarm.

**Operational Considerations**

***When a TVS is reported by the new TDA, consider the environmental wind and thermal profile, the signatures position in relation to the storm with which it is associated, time continuity, and the storm's range from the radar.*** Beyond about 60 km, the TVS will most likely be triggered by a strong mesocyclone and, as experience has shown, not all mesocyclones produce a tornado. Since the TDA works independently of the mesocyclone algorithm, the detection of a mesocyclone coincident with the TVS may support issuing a tornado warning. If the TVS is adjacent to a strong reflectivity gradient especially near the back of a storm, near a notch on the right rear flank of a storm, or near the tip of an appendage attached to the right rear flank of a storm, then the forecaster should give greater consideration to issuing a tornado warning.

Because of its sensitivity, the TDA shows continuity in time and space. TVS detections for the same storm on two or more consecutive volumes can suggest the validity of issuing a tornado warning. The TDA has identified TVSs nearly continuously on long-lived supercells typical of the Great Plains, especially ones that cyclically produce tornadoes. In the South and the Southeast, tornadoes may be embedded within squall lines. ***There is not enough experience available to comment on the performance of this algorithm when tornadoes occur within squall lines.*** The TDA tends to identify TVSs near the bend in a line echo wave pattern along the interface between warm moist

inflow and storm outflow. While many of the TVSs are false alarms, tornadoes do occasionally spin up under these conditions.

***Elevated TVSs are routinely generated by the TDA, but naturally do not score statistically as well as TVSs.*** However, ETVSs may be used as indicators of rotation aloft that could, with sufficient vorticity near the ground, produce a tornado. That is, they can be used to provide better lead times for identifying storms with the potential to produce tornadoes. A second use is to fill in gaps in TVS detections. Sometimes vertical continuity cannot be established between the lowest elevation and higher elevations. Other times ground clutter or range folding precludes measuring high gate-to-gate velocity differences. An elevated TVS may provide the time continuity to give a forecaster confidence to issue a tornado warning. ***One should be cautious about issuing a tornado warning based solely on ETVSs.***

***Remember that algorithms serve to provide users with guidance. Ultimately, the decision to issue or not to issue a warning is up to the individual forecaster using all available data, including spotter reports.***

## Build 9 and Build 10 Incompatibility

***If a Build 9 PUP connects to a Build 10 RPG***, TVS graphic symbols will be displayed (see Fig. 22), and the TVS attribute table will appear with the Build 10 parameters displayed. ETVSs will ***not*** be displayed on the Build 9 PUP since the PUP software is not configured for ETVS. ***TVS/ETVS alerts do not work properly and should be avoided with a Build 9/Build 10 connection.***

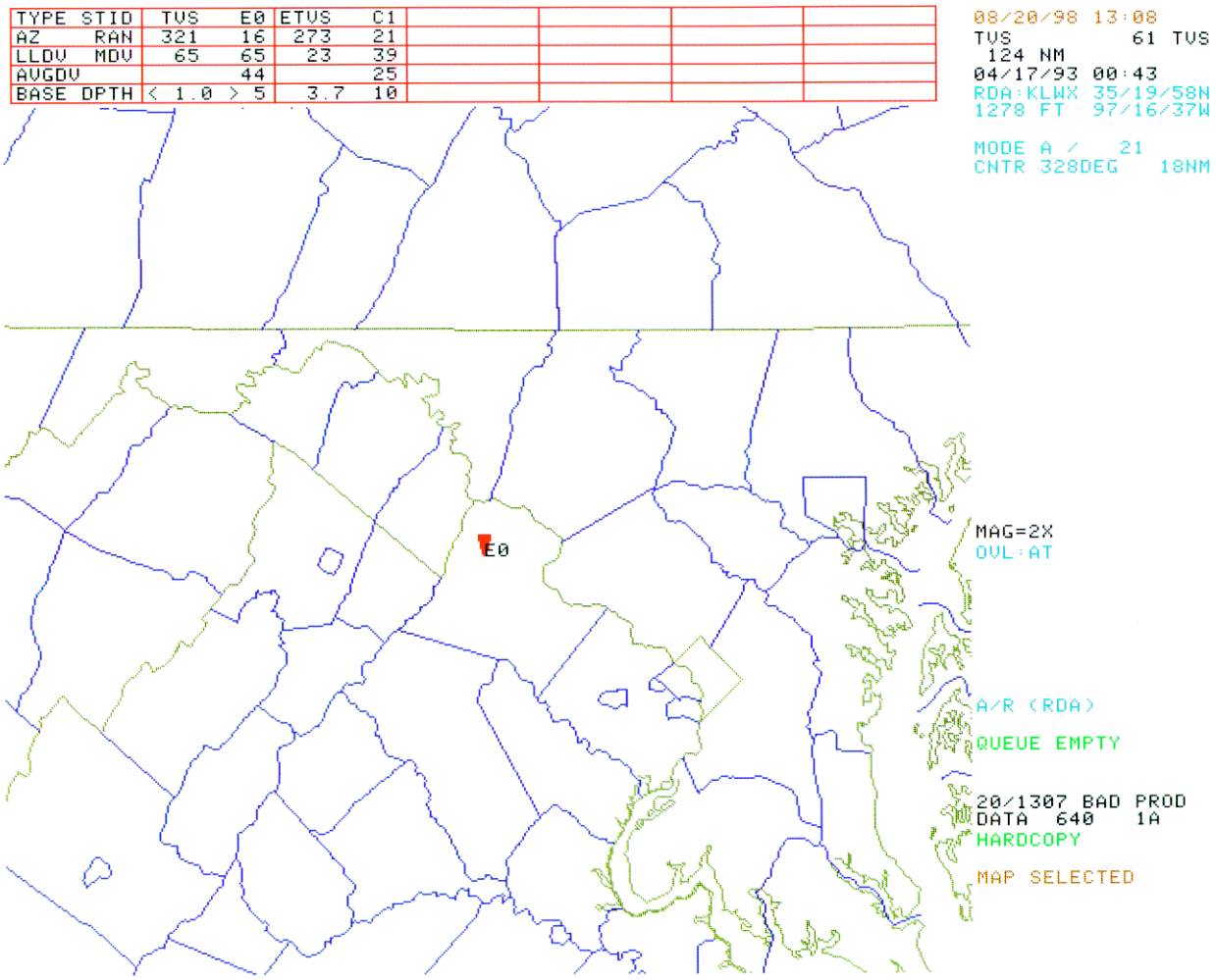


**Figure 22.** Build 9 PUP connected to Build 10 RPG.

***If a Build 10 PUP connects to a Build 9 RPG***, TVS graphic symbols will be displayed, and the TVS attribute table will show Build 9 parameters (see Fig. 23). No ETVSs will be shown, since the RPG is not configured for ETVS.

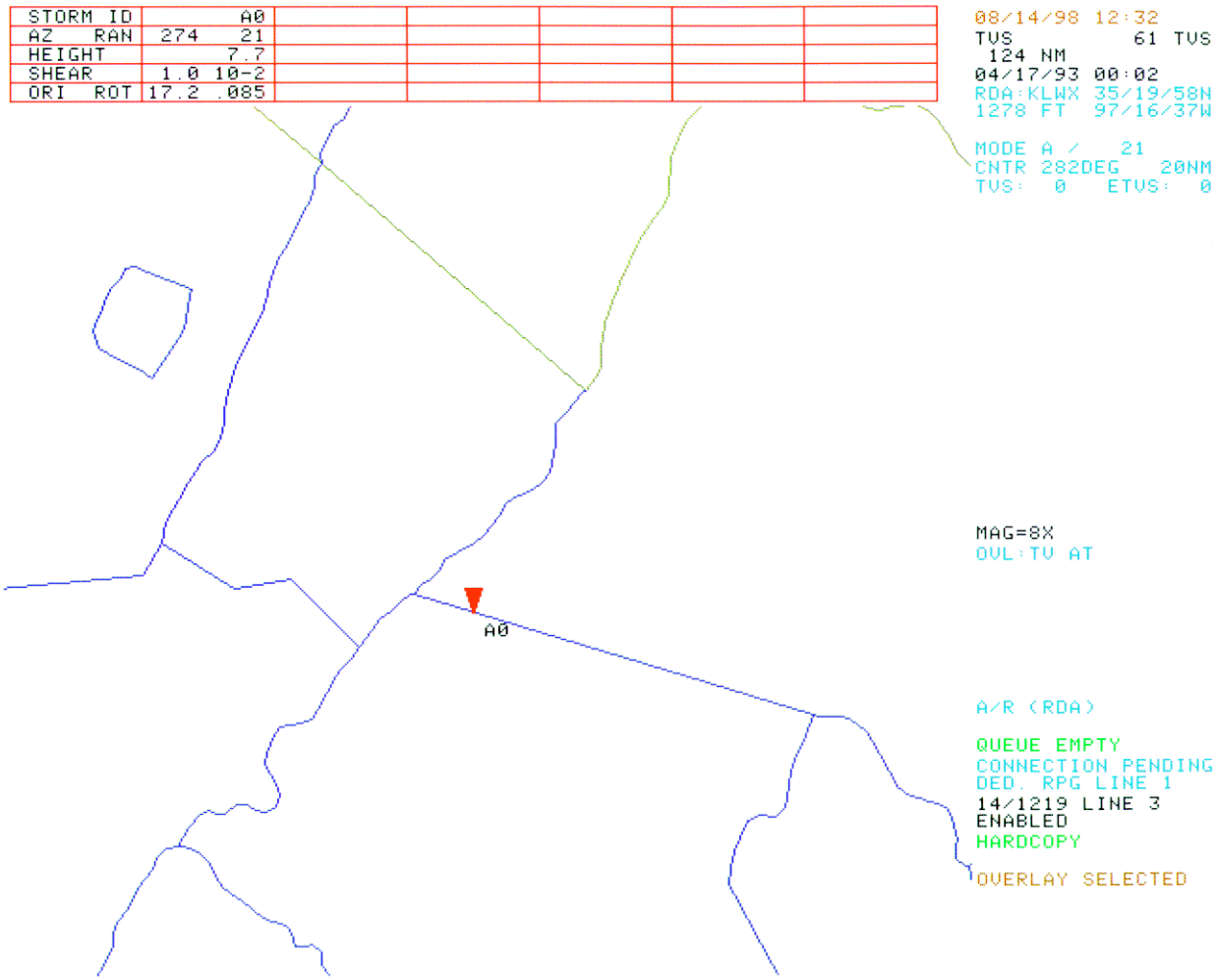


**Figure 23.** Build 10 PUP connected to a Build 9 RPG.

# New Hybrid Scan Reflectivity (HSR) Product

**Introduction**

Hybrid Scan Reflectivity (HSR, ID# 33) is a 16-data level reflectivity product with a range of 124nm from the RDA. It is based on reflectivity data from the lowest four elevation angles. The HSR product will assist in determining the accuracy of the precipitation products, and the Radar Coded Message (RCM), by allowing operators to view the reflectivity data used to generate these products.

**Process**

The RPG has always generated a Hybrid Scan Reflectivity ***internally*** before creating the precipitation products. Build 10 is making it possible to display this information at the PUP.

Reflectivity data displayed on the HSR product originate from the lowest four antenna tilts using one of two hybrid scan construction techniques discussed below. Corrections are also made to account for beam blockage, reflectivity outliers and isolated reflectivities. A “tilt test” is used to remove normal and abnormal ground clutter returns, caused by anomalous propagation, which have not been suppressed at the RDA.

**Sectorized Hybrid Scan Construction**

The sectorized hybrid scan utilizes data from higher tilts close to the RDA and lower tilts at greater ranges. The algorithm uses data from the 3.4º slice from the RDA out to 11nm; the 2.4º slice from 11 to 19nm; and the 1.5º slice from 19 to 27nm. Beyond 27nm, the algorithm uses the bi-scan maximization technique, which selects the highest reflectivity from either the 0.5º or 1.5º slice. For azimuths with beam blockage, the sectorized

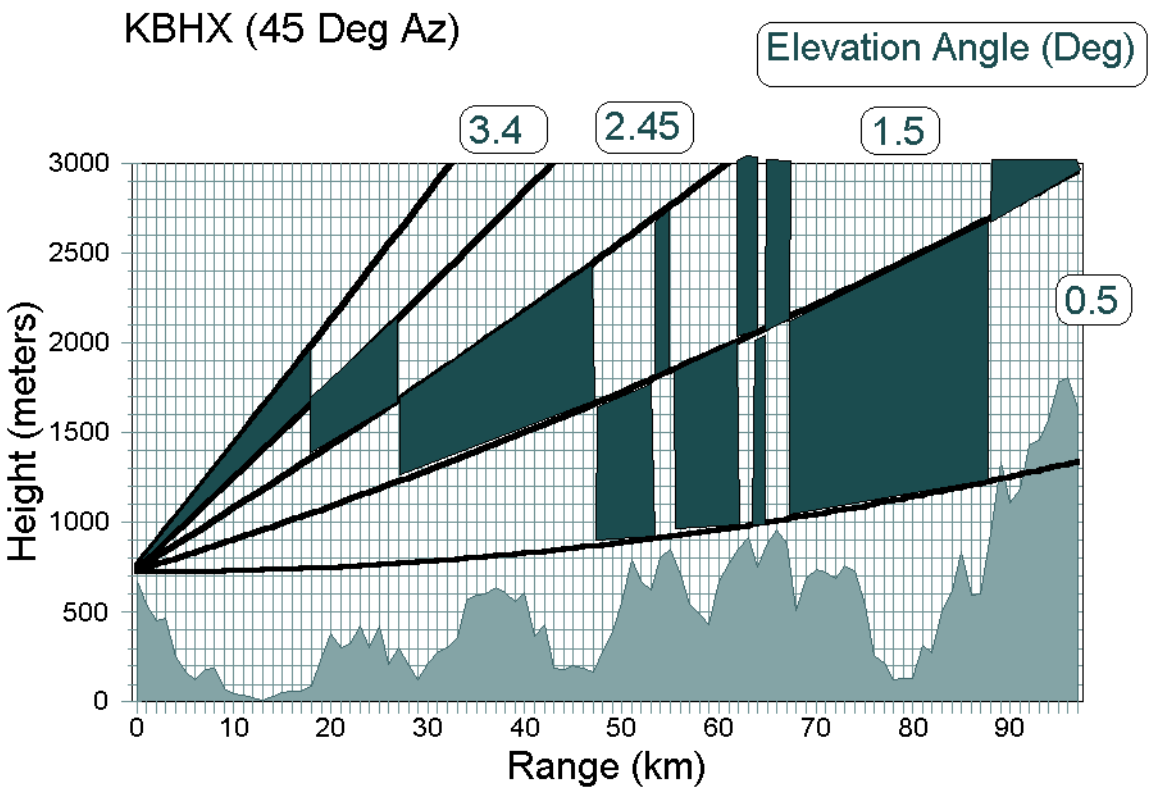


**Figure 24.** Operational Hybrid scan.

hybrid scan uses data from the next highest tilt (see Fig. 24).

**Terrain-Based Hybrid Scan Construction**

The terrain-based hybrid scan also utilizes data from the lowest four elevation angles. However, correcting for beam blockage is the only requirement for elevation selection. The lowest elevation angle is used wherever the bottom of the beam clears the terrain. For azimuths and ranges where blockage of the 0.5º elevation exists, 1.5º elevation is used instead (see Fig. 25).

**The Tilt Test**

For either type of hybrid scan, the 0.5º elevation may be unavailable due to the tilt test, which compares the areal coverage of echos at 0.5º and 1.5º. If a 75% (default) or greater reduction is found at 1.5º compared to the 0.5º slice, the algorithm assumes the echos at 0.5º to be clutter, and the data from this slice is removed from further processing. When this occurs, the message

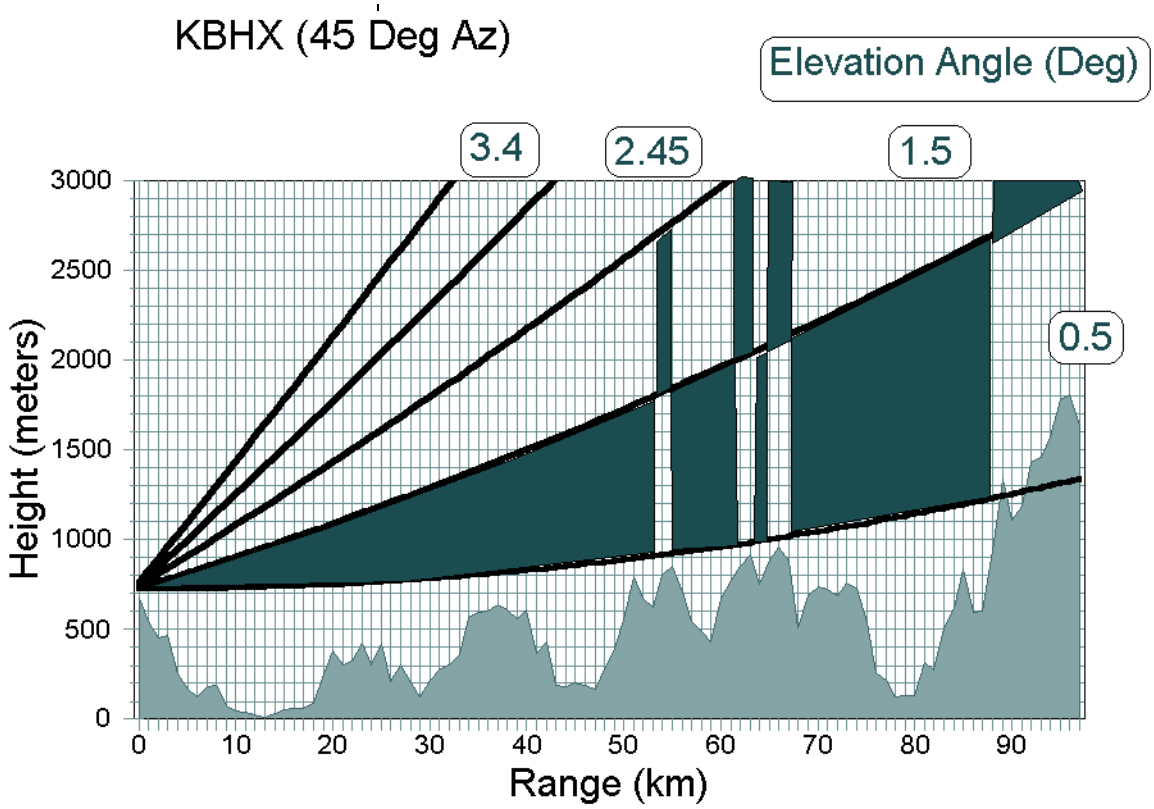


**Figure 25.** Terrain-Based hybrid scan.

"LOWEST TILT UNUSED" will be displayed in the status and annotations area just above the data levels on the product (see Fig. 26).

**Strengths**

The creation of the Hybrid Scan Reflectivity product allows the operator to view a previously "internal product", which will help operators assess the accuracy of the precipitation products and the RCM. Since the displayed reflectivity data is the result of numerous quality control steps, operators can quickly search for inconsistencies in the data. This product may also assist operators in discriminating between precipitation returns and ground returns due to anomalous propagation.

**Limitations**

The HSR product may display abrupt changes in reflectivity values at the hybrid scan ranges (see Fig. 24). In some instances, especially at RDA

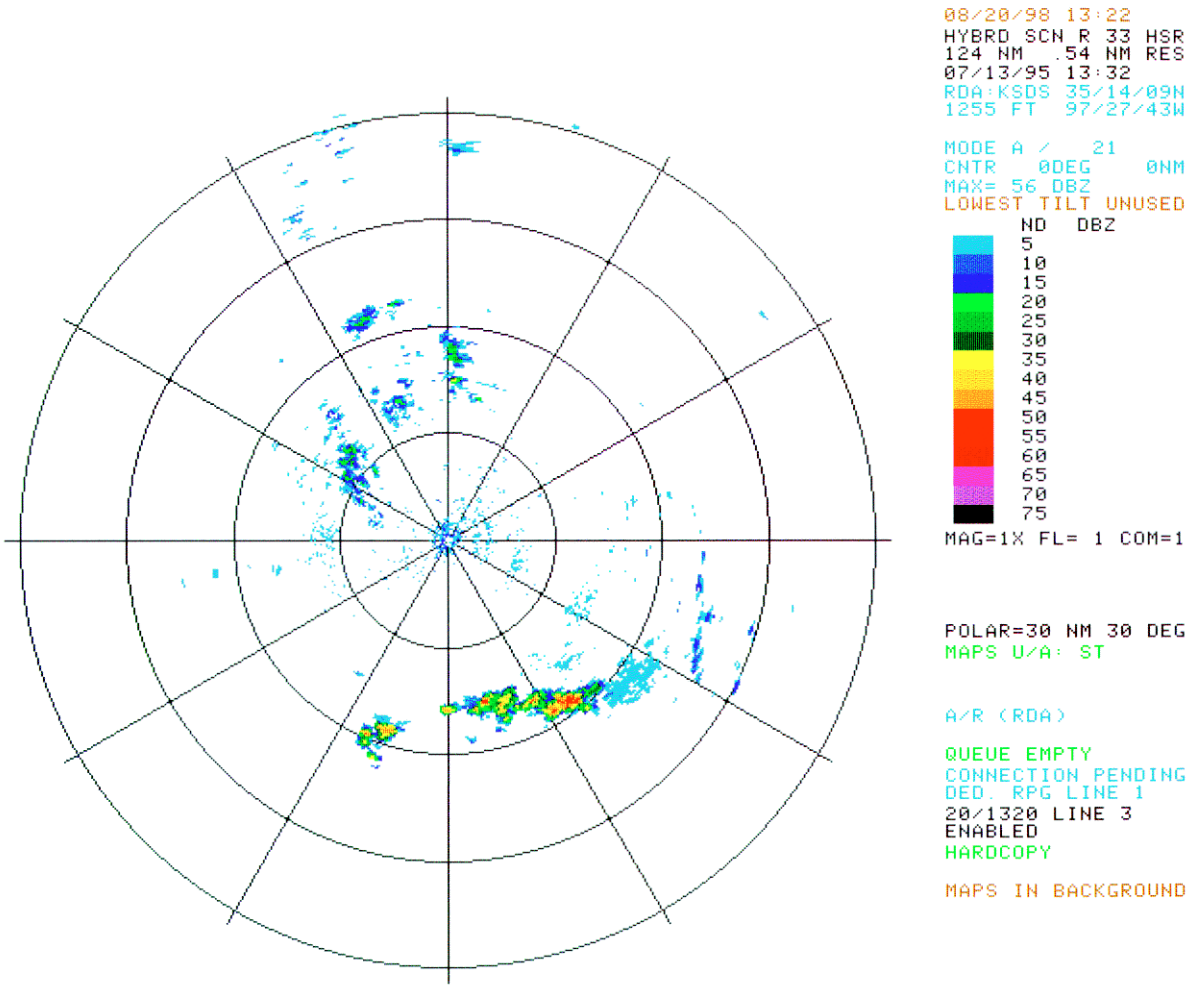


**Figure 26.** Hybrid Scan Reflectivity product.

sites located at higher elevations, it is possible that the tilt test may eliminate valid returns at 0.5º during some stratiform precipitation events.

# New LRM - Anomalous Propagation Removed (APR) Product

**Introduction**

The Layer Composite Reflectivity Maximum - Anomalous Propagation Removed product (APR, ID# 67) is an 8-data level reflectivity display similar in appearance to the existing Layer Composite Reflectivity Maximum (LRM) products. The APR product does not replace any of the existing LRM products. It is derived from the output of an algorithm which processes base reflectivity, velocity, and spectrum width data with the goal of distinguishing between meteorological returns and returns from ground clutter/AP. The algorithm will generate a Surface to 24,000 ft Layer Composite Reflectivity Maximum product every volume scan with the algorithm-identified ground targets removed (see Fig. 27).

**APR Algorithm**

The algorithm used to identify and remove clutter was developed at **Lincoln Laboratories,** and is based on the observation that ground targets tend to affect mainly the lowest antenna tilts, and are typically associated with low radial velocity and low spectrum width.

The algorithm separates the atmosphere into three regions based on distance from the RDA, and altitude above the surface. A different clutter removal technique is applied to each region, based on known observations of the appearance and location of clutter.

The ***Omit All*** region is defined as that portion of the atmosphere within 45 km of the RDA, and below 1 km in altitude. All targets in the Omit All

region are considered clutter and are removed (see Fig. 28).

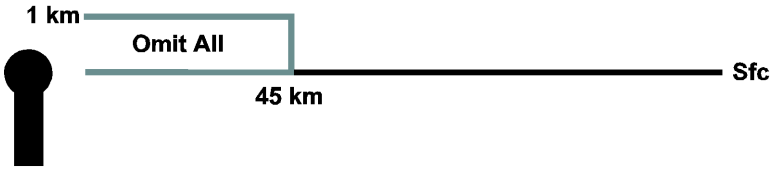


**Figure 28.** Omit All Region.

The ***Accept If*** region is defined as that portion of the atmosphere within 103 km of the RDA, at 0.5º and below 3 km in altitude, and not within the Omit All region. A target in the Accept If region is

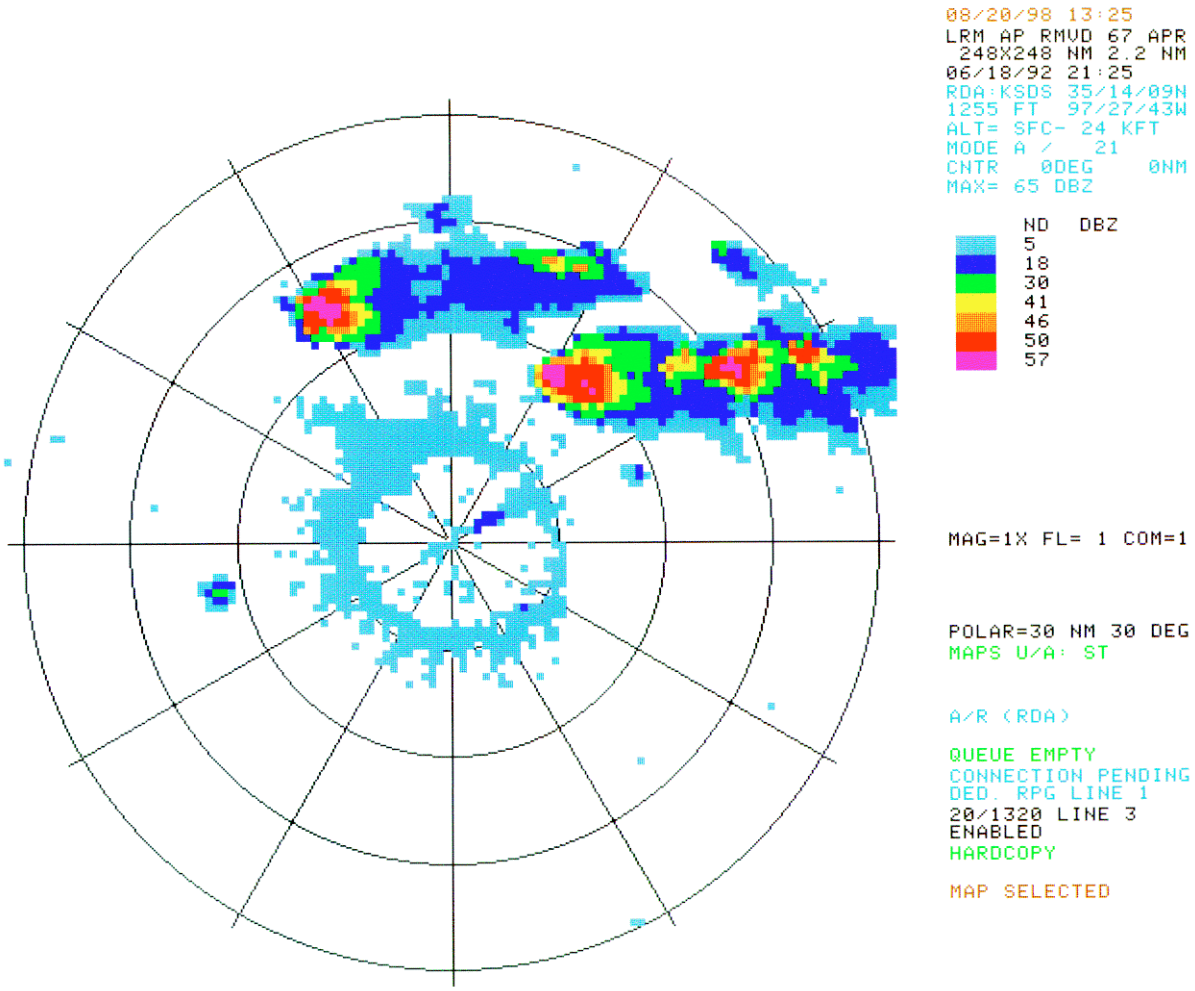


**Figure 27.** LRM-AP Removed product.

accepted if its velocity is ≥ 1.0 m/s ***and*** its spectrum width is ≥ 0.5 m/s. Essentially, a target in this region is assumed to be clutter, but it will be ***accepted*** as being meteorological ***if*** movement is indicated by either velocity or spectrum width data (see Fig. 29).

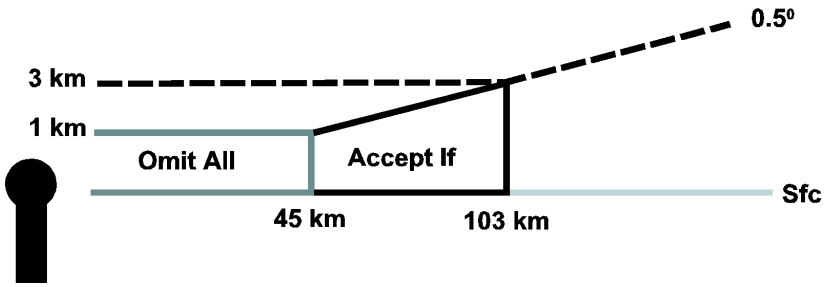


**Figure 29.** Accept If Region.

The ***Reject If*** region is defined as that portion of the atmosphere within 230 km of the RDA, below 5° in elevation, and not within either the Omit All or Accept If regions.

A target in the Reject If region is rejected if it possesses a velocity <1.0 m/s and a spectrum width < 0.5 m/s. Essentially, a target in this region is assumed to be meteorological, but it will be ***rejected*** as being clutter ***if*** little or no movement is indicated (see Fig. 30).

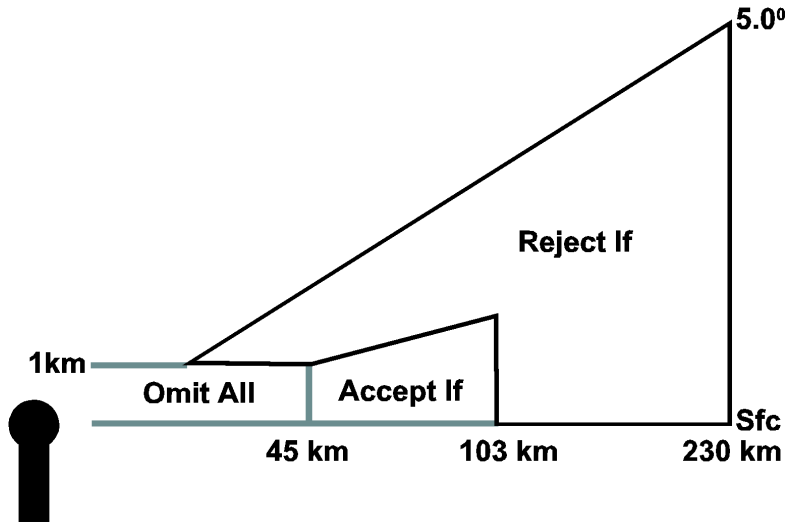


**Figure 30.** Reject If Region.

## Strengths

The APR algorithm attempts to distinguish weather targets from clutter targets.

## Limitations

The algorithm works best if traditional clutter filtering is applied before the algorithm begins processing data. The algorithm assumes ***all*** low level data within 45 km is clutter, which may result in valid data being dropped from the product. Current adaptable parameter values may not be the optimum settings, and further testing may be needed to enhance algorithm performance.

# Build 10 Enhancements

## Ability to Select the Lower Boundary Height of the Lowest LRM Layer

**Introduction**

Operators may now specify the depth of the lowest layer of the Layer Composite Reflectivity products by changing the base of the lowest layer. The top of the layer remains fixed at 24,000 feet MSL. The authority for modifying the lower boundary height is at the Unit Radar Committee Level. Changing the lower boundary height of the lowest LRM layer affects both the LRM and LRA products, but not the new LRM-AP Removed product (see Fig. 31).

**Operator Actions**

Changes to the lower boundary height of the lowest LRM layer are made at the UCP by entering **SE,*****,L** and pressing **<RETURN>**, where ***** is the first level password. This displays the Layer Product Parameters edit screen. Type **M** and press **<RETURN>** and make the desired change under column L0.

Only the lowest layer height definition (L0) may be modified under the direction of the URC. The lowest layer height must be defined above the station elevation and the layer depth must be at least 6,000 feet. The top of the layer will remain fixed at 24,000 feet.

**Strengths**

Operators now have the capability to vary the thickness of the lowest layer on the LRM and LRA products. The ability to raise the lower layer boundary may assist forecasters in the identification of pulse type storms and first echoes, and may also help differentiate real echoes from non-precipitation echoes.

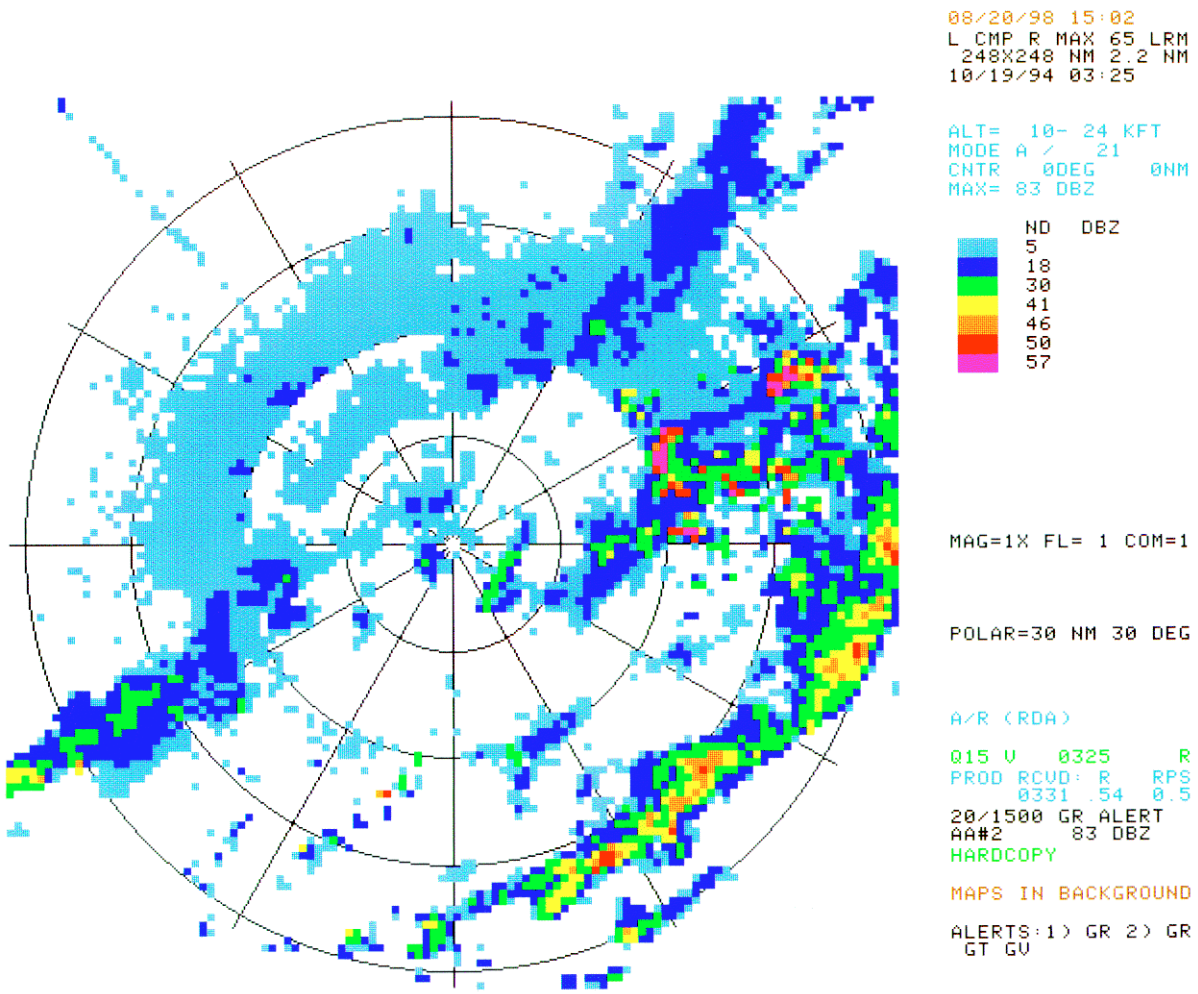


**Figure 31.** LRM lowest layer product with base changed to 10,000 ft MSL.

```
                                LAYER PRODUCT PARAMETERS          PAGE 1 OF 1

COMMAND: SE,*****,L,
FEEDBACK:                                                          OPER A/

                  (M)odify     (E)nd     (C)ancel

                       LAYER REFLECTIVITY
          L0 Hgt     L1 Hgt     L2 Hgt     L3 Hgt     Rng
          Ft MSL     Ft MSL     Ft MSL     Ft MSL     km
-------------------------------------------------------------------------
Current      0          24         33         60      460
-------------------------------------------------------------------------
MIN          0           6         12         18       40
MAX         52          58         64         70      460
```

**Figure 32.** LRM lowest layer product with base changed to 10,000 ft MSL.

**Limitations**

With the ability to raise the lower layer boundary, the operator is reducing the number of tilts used to generate the lowest layer composite. The top of the lowest layer remains fixed at 24,000 ft MSL. As with all products, the lowest layer of the LRM is susceptible to non-precipitation echoes.

## Time Lapse Default Set to Automatic Continuous Loop

**Introduction**

This Build 10 change will allow any Time Lapse to automatically remain active in a continuous looping mode. Previously, the images looped once and then halted, requiring the operator to select the CONTINUOUS LOOP box on the Graphics Tablet to keep the Time Lapse active.

**Operator Actions**

This Build 10 modification reduces the number of steps required for an operator to invoke a Time Lapse and keep it active. Operators now select the Time Lapse of choice; and the looping mode will run continuously until a new Time Lapse is selected, the original one is halted, or the screen is cleared or replaced with another product. Since there is no longer a need to select the CONTINUOUS LOOP box on the Graphics Tablet, the box has been removed.

## More Detailed Information Available When Examining User Functions

**Introduction**

This change allows operators to display additional information while examining a User Function. In

```
               EXAMINE/EDIT USER FUNCTION  3:  SRM_4PNL_MID_RANGE  Page 1 of 1
COMMAND:  U,
FEEDBACK: EXECUTED - U,EXA,3

           [Each edit cmd must be preceded by "(U)SER FUNCTION,"]
EDIT CMDS: (DEL)ETE,<LINE#>                    (R)EPLACE END,[(E)ND OR <UF#>]
           (I)NSERT,<LINE#>                    (REN)AME UF TITLE, <NEW TITLE>

 1 D,G,SRM                          R1
 2 D,G,SRM                          R2
 3 D,G,SRM                          R3
 4 D,G,SRM                          R4
 5 ALL QUADRANTS                    R
 6 RECENTER MAGNIFY 8X              R
 7 U,EN,E
```

**Figure 33.** Examine/Edit User Function screen. (Build 9)

previous builds, the only information provided was the root command that was entered. For example, when requesting a Storm Relative Velocity Map product, the only information provided was D,G,SRM (see Fig. 33).

**Operator Actions**

Build 10 software allows additional data to be displayed after executing the U,EXA,<UF#> command. The data levels, resolution, elevation angle, RPG, and the time appear in the same format as it was entered on the D,G,<prod-name> screen. There is no need to redefine existing User Functions to see the additional information (see Fig. 34).

## Ability to Select a Storm from Any Graphic Attribute Table

**Introduction**

Operators often choose a storm (cell) for analysis by clicking on the centroid with the Graphics Tablet puck, then selecting a function such as CELL TRENDS or RECENTER/MAGNIFY. A storm of

```
                    EXAMINE/EDIT USER FUNCTION  3:  SRM-CLOSE       Page 1 of 1
COMMAND:  U,
FEEDBACK: EXECUTED - U,EXA,3

           [Each edit cmd must be preceded by "(U)SER FUNCTION,"]
EDIT CMDS: (DEL)ETE,<LINE#>                    (R)EPLACE END,[(E)ND OR <UF#>]
           (I)NSERT,<LINE#>                    (REN)AME UF TITLE, <NEW TITLE>

 1 D,G,SRM          0.5 KMPX 22:47   L1
 2 D,G,SRM          2.4 KMPX 22:47   L2
 3 D,G,SRM          4.3 KMPX 22:47   L3
 4 D,G,SRM          6.2 KMPX 22:47   L4
 5 ALL QUADRANTS                     L
 6 RECENTER MAGNIFY 8X               L
 7 U,EN,E
```

**Figure 34.** Examine/Edit User Function screen. (Build 10)

interest can now be selected from a graphic attribute table or directly from a geographical display.

## Operator Actions

To select a cell, the operator must first display any graphic product which supports an attribute table. Once the operator selects the cell by placing the cursor on the appropriate row or column, the AZRAN of that cell is stored in memory and can be used with the following four PUP functions:

- CELL TRENDS
- CURSOR HOME DEFINE
- RECENTER/MAGNIFY (any magnification)
- AZRAN SELECT

The AZRAN SELECT function can then be used to select a window product centered on the cell, such as Storm Relative Region, Severe Weather Analysis products, Weak Echo Region, etc.

Some attribute tables contain cell information in columns, while others contain cell information in rows. Figure 35 shows a Combined Attribute

Table, available only with a Composite Reflectivity product. Cell information in this case is given in row format. When the operator selects any portion of the row, it places the storm's AZRAN into memory (see Fig. 35) for use with subsequent PUP functions.

| STM ID | AZ/RAN | TVS | MESO | POSH/POH/MX SIZE | VIL | DBZM HT | TOP | FCST MVMT |
|---|---|---|---|---|---|---|---|---|
| V1 | 336/18 | TVS | MESO | 0/ 40/<0.50 | 18 | 56 6.9 | 20.2 | NEW |
| C1 | 283/21 | ETVS | 3DCO | 0/ 0/ 0.00 | 22 | 55 13.8 | 13.6 | 302/23 |
| F1 | 349/28 | ETVS | 3DCO | 0/ 0/ 0.00 | 4 | 46 13.4 | 18.1 | NEW |
| **J1** | **273/56** | **NONE** | **UNCO** | **0/ 0/ 0.00** | **8** | **46 11.3** | **31.3** | **336/36** |

**Figure 35.** Combined Attribute Table.

## Strengths

This Build 10 change assists operators in locating storms (cells). When numerous storms exist, it may be easier for the operator to select a storm from an attribute table rather than from a geographic display. If an operator magnifies the screen to a point where a storm of interest is no longer on the display, he/she can simply go to the attribute table and select it there, rather than zooming out and re-selecting the storm.

## Limitations

The AZRANs listed in the TVS and MESO attribute tables are for TVS and MESO features, ***not storm centroids***. This may cause problems if the operator tries to generate a Cell Trends Display from a TVS or MESO attribute table. The Cell Trends function looks for a centroid within 5 nm of the selected AZRAN. This is called the "association distance". If the centroid is within 5 nm of the selected point, the Cell Trends function will display the trend information for that centroid. If not, the feedback "NO CELL WITHIN 5 NM OF SELECTED POINT" will be generated and displayed in the status and annotations area. (Note

that the Cell Trends association distance has been increased from 2 nm to 5 nm in Build 10 to accommodate the new attribute table function.)

## New Utility: BACKFILE

**Introduction**

A new utility called BACKFILE is available at the System Consoles of the RDA, RPG and PUP. This utility automates the process of copying files from the hard disk to a SCSI tape, making it easier for operators to create backup tapes. Operators can either have the system automatically back up a default file set unique to each system, or enter individual filenames from the keyboard. This utility calls the BACKUP task and assists users by eliminating the need to enter repetitious data from the keyboard. Using the BACKFILE utility is straightforward. There are two command options:

**OPTION 1: Default Files**

Operators using the BACKFILE command have the option of copying a default set of files from the hard drive to tape. The default file list is different for each system. The default filenames are shown below:

| RDA | RPG | PUP |
|---|---|---|
| ADAPT.DAT | ADAPT.DAT | ADAPT.DAT |
| ADAPTCUR.DAT | ADAPTONE.DAT | BACKGRND.DAT |
| RDACALIB.DAT | ADAPTTWO.DAT | EBMFILE.DAT |
| LONGTERM.DAT | BACKGRND.DAT | UFFILE.DAT |
| RDABYPAS.DAT | HYOCCULT.DAT | DEFAULT.OS |
| RDACLUT.DAT | HYSECTRS.DAT | |
| DEFAULT.OS | DEFAULT.OS | |

**Step 1.** Type **BACKFILE** and press **<RETURN>**.

The BACKUP task begins, and copies the appropriate files to the SCSI tape using the verify option. To skip the verify option, on the command line, enter: **BACK-FILE,NV** and press **<RETURN>**. The files have been successfully copied to tape when the message **BACKUP: END OF TASK 0** appears.

**NOTE:** At the PUP System Console, a PUP-DOWN command must be issued before using the BACKFILE utility. At the RDA and RPG System Consoles, it is not necessary to bring the system down before using this utility.

## OPTION 2: User-Selected Files

Operators using the BACKFILE command have the option of copying a list of user-selected files from the hard drive to tape. The commands are shown below:

**Step 1.** Type **BACKFILE CON:** and press **<RETURN>**.

The BACKUP task begins and will use the verify option. To skip the verify option, on the command line, enter: **BACKFILE,NV CON:** and press **<RETURN>**.

**Step 2.** At the **BACKUP>** prompt, enter each file-name on a separate line, ending each line by pressing the **<RETURN>** key.

**Step 3.** When all filenames have been entered, type **./** and press **<RETURN>**.

User selected files are written to tape.

The files have been successfully copied when the message **BACKUP: END OF TASK 0** appears.

**NOTE:** At the PUP System Console, a PUP-DOWN command must be issued before using the BACKFILE utility. At the RDA and RPG System Consoles, it is not necessary to bring the system down before using this utility.

## Slice Products Now Default to the Lowest Tilt

**Introduction**

Build 10 software has changed the default display for the .54nm resolution elevation products from the “latest received”, to the “latest received at the lowest elevation angle”. This change allows easier access to the most recent 0.5º, 0.54nm resolution products.

**Operator Impacts**

With previous software, selection of an elevation product Graphic Tablet box displayed the most recently received product of that type. As a result, operators were never sure which resolution or elevation angle would appear. Experience has indicated that most users wish to display products at the 0.5º antenna tilt with 0.54nm resolution for initial analysis. This Build 10 change makes it easier for operators to view Base Reflectivity, Base Velocity, Base Spectrum Width, and Storm-Relative Mean Radial Velocity products with these parameters.

Other products not able to utilize this software change are:

1. Elevation products which are not displayed with a 0.54nm resolution (e.g. SRR).
2. Elevation products for which a 0.54nm resolution is not currently available in the PUP database.
3. Products which do not display information for specific elevation angles (e.g. VIL, CR).

***NOTE:*** Operators are still able to monitor the PROD RCVD status line and use the DISPLAY PRODUCT box to display incoming products at other elevations and resolutions.

## Archive II Status Messages Added at the UCP

### Introduction

New status messages have been added at the UCP to provide operators with a more detailed description of the current state of the Archive II device at the RDA. The following new status messages are available:

**FST FWD -** Indicates the tape device at the RDA is fast forwarding.

**TAPE XFR -** Indicates the tape device is swapping tapes in the “jukebox”.

**CK LABEL -** Indicates the tape device is checking a label.

In addition, a tape number is now included with some status messages. For example,

**FST FWD 01** indicates tape #1 in the 8mm tape drive is being fast forwarded.

**Operator Benefit**

The addition of the new status messages gives operators a more complete picture of the status of the Archive II tape device at the RDA.

## APUP Communications Changed to 14.4Kbps...PUP RPS Lists Increased to 31 Products

**Introduction**

Narrowband communication speeds have been upgraded from 9.6Kbps to 14.4Kbps, which is the maximum allowed with the existing hardware. As a result of the faster transmission speed, more products can be transmitted during a volume scan.

**Operator Benefit**

Higher narrowband communication speeds allow an increased product capacity in the Current and Adaptation RPS Lists. A total of 31 products can be placed on the RPS lists, compared with the previous limit of 20 products. (The maximum number of products for RPGOPs will remain at 50.)

**Limitations**

Outdated telephone equipment at some sites across the country will limit the ability to support the faster communication speeds. As a result, some narrowband interfaces must remain at 9.6Kbps. For the offices that are upgraded to the 14.4Kbps, operators should be aware of the possibility of narrowband load-shedding with the ability to add more products to the RPS lists.

# Elimination of the Turbulence Algorithm / Products

Implementation of Build 10 has eliminated the rarely used Layer Composite Turbulence Average (LTA), and Maximum (LTM) products. The deactivated products will not be allowed on the RPS list, nor can they be displayed via a one-time request.

# Build 10 Fixes

## Linear Motion Clock Times Corrected

**Introduction**

In Build 9, the Linear Motion function has, on occasion, displayed the top of the hour minutes as “60" instead of “00". For example, a top of the hour time that should be displayed as 1900 has been incorrectly displayed as 1860. This oversight has been corrected in Build 10, and the Linear Motion display will now show the top of the hour clock time as xx00 (see Fig. 36).

## All SRM Products Read from Optical Disk Will Now Time Lapse

**Introduction**

Before Build 10, SRM products read from an optical disk or a SCSI tape may or may not have time lapsed properly, depending on when the products were originally saved. The products were actually in the PUP database, but the Time Lapse function would not place them into a loop. Build 10 has corrected this problem so that all SRM products can be used with the Time Lapse function.

**Problem**

This problem occurred due to information stored in the SRM PARAM1 and PARAM2 fields. The Time Lapse function assumes these fields will always be zero (centered at the RDA). Earlier software builds centered the alert-paired SRM products on the alert, not at the RDA. As a result, the PARAM1 and PARAM2 fields sometimes contained values

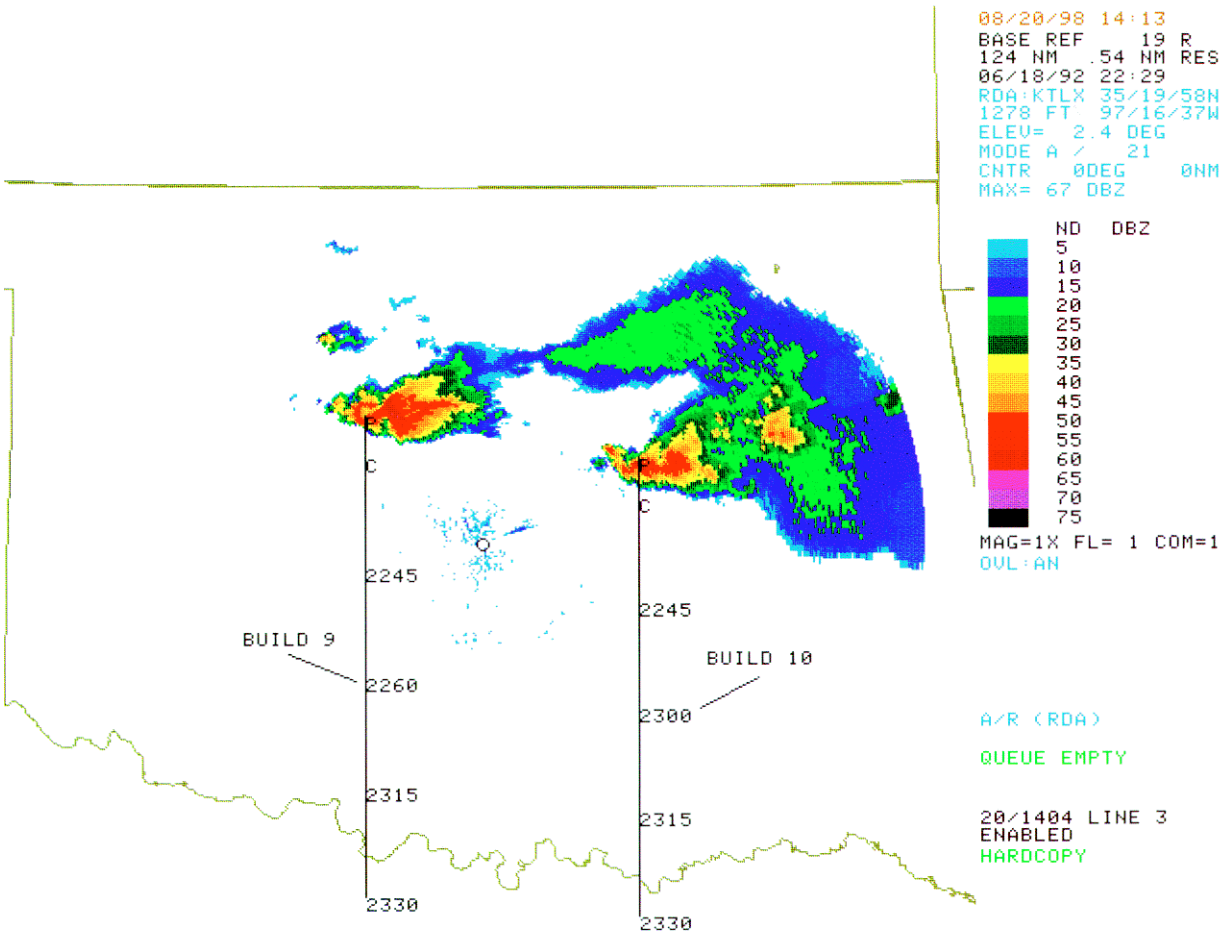


**Figure 36.** Linear motion problem and correction.

other than zero, and the Time Lapse function would ignore these products.

Operators will observe that all SRM products will now time lapse successfully.

**Operator Impact**

## PUP No Longer Deletes Requests from Dial-out Queue During Error Conditions

**Introduction**

In Build 9, when certain types of communication line errors were detected on a dial-out line, the PUP either cleared the dial-out queue or performed a selective clearing of requests. For sites with multiple dial-out lines, an error on one line may have caused the software to clear out the requests from both lines. This led to an unnecessary loss of requests which could have been transmitted successfully over another dial-out line. Software changes have been made such that the dial-out queue will not be deleted.

**Operator Impact**

Operators will notice an increase in the number of satisfied dial-out requests.

## PUP Dial-out Line No Longer Stays Connected for an Excessive Period of Time

**Introduction**

In Build 9, if a PUP was connected to an RPG via a dial-out line and data flow was non-existent, the PUP may have stayed connected to the RPG for an excessive period of time. The PUP waited 12 minutes before reporting a product overdue; and, if the product did not arrive, the PUP then queried the dial-out queue and processed the next request and again waited up to 12 minutes. This process continued until all requests had been processed. Software has been changed so that, if the PUP

detects an overdue product, an automatic disconnect is issued.

**Operator Impact**

Sites will no longer experience excessively long connect times and associated higher telephone bills.

## OPTREAD No Longer Continues to Execute After Disk Fails to Mount On

**Introduction**

In Build 9, when the OPTREAD utility failed to properly mount on an optical disk, an error message was generated; but users were still allowed to make menu selections. Any data displayed from the OPTREAD menu after the error condition occurred was likely garbled or inaccurate. Software has been modified to stop processing when it fails to properly mount the disk on-line.

**Operator Impact**

OPTREAD will no longer display garbled or inaccurate information when a disk fails to “mount on” properly.

## OPTREAD Software Modified to Add New RPG Mnemonics and Correct Inaccuracies

**Introduction**

When OPTREAD was used to examine maps on an Archive III or IV optical disk, some RPG mnemonics were found to be incorrect, or the RPG ID number was listed instead of the mnemonic. Soft-

ware has been modified to correct these minor inaccuracies.

**Operator Impact**

All RPG mnemonics are now correct and will result in less confusion when examining maps on an optical disk.

## Product Received Messages Will Now Be Displayed in Training Mode

**Introduction**

A software error in the PUP archive task in Build 9 prevented the display of PRODUCT RECEIVED messages while in Training Mode. The messages were not being displayed on the RPG Product Status lines on the graphic and alphanumeric displays. In addition, the latest version of the “paired” products (graphic products having a corresponding alphanumeric product) were not being displayed. Products that were read off optical disks also had no PRODUCT RECEIVED messages displayed.

**Operator Impact**

Build 10 software modifications have corrected these problems. Operators that use Training Mode at the PUP will have the PRODUCT RECEIVED messages displayed, and the latest version of paired-products will be available.

## NIDS Vendors No Longer Get More Products Than Intended

**Introduction**

The default Generation and Distribution Control (GDC) list at the RPG contains the minimum num-

ber of products scheduled for generation each volume scan. The URC has the authority to add products to this list, but may not subtract any products. Furthermore, any products added to the list must neither be archived, nor sent to Other Users (i.e. NIDS vendors).

**Process**

In previous software builds, when a field site added slice products to the GDC, it was not possible to prevent these from also being distributed to NIDS vendors. This sometimes resulted in load-shedding problems for the vendors.

**Benefit**

RPG software has been modified to allow a negative number in the NAPUP, PUES, RFC and OTH USR columns in the GDC. These negative numbers have a meaning similar to those found in the generation and auto-archive columns in the GDC. For example, a negative 4 in the OTH USER column now results in the lowest four elevation slices being sent to NIDS vendors, independent of the value in the generation column.

## Archive IV Problems Corrected

**1.** Certain errors which occurred during auto-archive at the PUP left the system in a condition where the archive function ceased to operate and a PUPDOWN/PUPUP sequence was required to recover. Symptoms of the problem were the archive status screen indicated that archive was active, but the disk was mounted off. Software was changed so these error conditions will not require the PUPDOWN command.

2. If the “Cancel Archive” command was issued immediately after issuing the A,A,D command, the response at the Applications Terminal was CANCEL PENDING followed by ARCHIVE NOT ACTIVE. However, the A,A,D command executed anyway. The operator was not able to cancel archive and was not given the correct feedback. Software changes were made to alleviate this problem.

3. If an archive function did not complete due to an error condition, subsequent archive commands resulted in the feedback: WAIT FOR COMPLETION OF COMMAND. Operators had to issue a PUPDOWN/PUPUP sequence to correct the problem. Changes were made in Build 10 so the system will now correctly accept subsequent archive commands.

# Appendix A: Additional Changes

## PUP Help Screen Corrections

1. The help screen for Hardware Implementation incorrectly stated that halfword 3 described the number of Other User Dial-in communications lines. The text now correctly reads that this value describes the total number of lines for Other User Dial-in and Dedicated communications.
2. In Build 9, the help screen for PUP Alert Processing Edit Screen was incorrect. It stated that for alert category 15, MAX 1HR PRECIP, the units were ".1 inches". The unit information now correctly reads in "inches", not "tenths of an inch".
3. The Product Names and IDs Help Screen incorrectly identified the product mnemonic for product ID number 44 as SWW. The correct mnemonic for ID number 44 is SWV, and Build 10 has implemented this change.
4. Two pages of the PUP's Archive Menu Help Screen were modified because inaccuracies were discovered. One help screen incorrectly stated that the partial command to retrieve background maps from optical disk was A,R,B, when in fact, the correct partial command is A,R,B,<RPG>. The help screen also stated that in the full command A,R,B,<RPG>,<FILE NO.>, the FILE NO specifies the auxiliary background map file to be ***written*** to disk. The screen should read that the FILE NO portion of the command specifies which auxiliary background map file will ***receive*** the map data.

## Task Pause During Archive IV Map Merge Corrected

The automatic Archive IV merge of local edits and original background map data sometimes caused the A408 task to pause. Build 10 has changed specific software that will prevent the A408 task from pausing, allowing successful completion of the Archive IV process for local background maps.

## Additional Archive IV Problems Corrected

1. In Build 9, when an I/O error occurred during auto-archive at the PUP, the software generated an AUTO ARCHIVE PAUSED message. This error condition should result in the archive function being canceled, not paused. Build 10 software has been implemented to cancel archive during I/O errors.
2. When a write-protected optical disk is loaded and the archive resume command is issued after the completion of the A,R,D command, the resume function fails and returns the message ARCHIVE UNIT 1 ERROR 6. Build 10 software will mount the disk on protected if the operator issues a resume command during a read.

## Graphics No Longer Hang When Using OVERLAYS ERASE Function

When operators selected the OVERLAYS ERASE box while the graphics screen was clear, an error resulted in a graphics hang. A PUPDOWN/PUPUP sequence was required to recover. Build 10 software has been changed to prevent the erase overlays request from being carried out if the graphics screen is clear.

## Line Noisy Status Messages Corrected

When the PUP communications task reported that a line was noisy, two problems occurred. First, the RPG Product Request Status message UNABLE TO CONNECT DED. LINE xx was inadvertently displayed. Second, software code existed to suppress ***line noisy*** messages to display once every two minutes, but no similar code existed to suppress the ***returned to normal*** message. This sometimes resulted in the display of returned to normal messages without a corresponding line noisy message. Changes were made so these problems will not occur in Build 10.

## USP Product on the PUP RPS List Will Now Auto-Display

In Build 9, if the User-Selectable Precipitation (USP) product was placed on the PUP RPS list with the End Hour parameter left blank, the software would not include the USP product when the auto-display function was invoked. Build 10 corrects this problem, and the USP product will now auto-display.

## Velocity Dealiasing Algorithm Change to Support TDA

The Build 10 Velocity Dealiasing Algorithm (VDA) has been changed such that data dropouts will no longer occur in regions of high atmospheric shear. This algorithm restores velocity data which was previously discarded. The Build 10 VDA will make two additional passes through the velocity data using relaxed thresholds in an attempt to find a valid velocity value. The result is that ***velocity data dropouts will no longer occur***. This will improve the performance of the Tornado Detection Algorithm which is also being implemented in Build 10.

## Communication Card Automatically Re-Initializes After Becoming Inactive

A problem can arise in the communications hardware which manifests itself by a loss of data flow from the RPG to the PUP. Operators notice that products suddenly stop arriving from the RPG. Software has been written to detect this problem, and to automatically re-initialize the communications hardware. Operators will notice system status messages “Line xx Initializing”, and “Line xx Init Complete” appearing on the PUP graphics display and also in the System Status log (command S,S at the PUP Applications Terminal) as the hardware is being initialized.

## User-Friendly VCP Sector Definition Implemented

Volume Coverage Pattern sector definitions have changed such that the azimuth listed is now the ***beginning azimuth*** for that sector. Operators will find that the new definition is easier to interpret.

# Appendix B: Other RPG/PUP CCRs Implemented in Build 10.0

| | |
|---|---|
| NA94-34702 | Satellite Communication with DOD Pacific and Alaska WSR-88Ds |
| NA95-33502 | FAA OS251-NXRAD-004, RPG Status Information to RMMS |
| NA95-33504 | FAA OS251-NXRAD-006, RPG Control to RMMS |
| NA96-09201 | Displayable SPD Does Not Meet Requirements (Phase Out Old Gage Reports from Displayable SPD Product) |
| NA96-16202 | Efficiency Change of Buffer Management Task |
| NA96-17902 | Two New Debug Options for S309 |
| NA96-17903 | Anomalous Propagation Removal Algorithm |
| NA96-18402 | Append Adaptation Data to DPA Product |
| NA96-18403 | Enhance DHR Product to Support FFP Processing |
| NA96-18405 | Improved Algorithm for Bias Determination |
| NA96-20101 | TPMS Monitoring |
| NA96-21302 | Narrowband Lines Become Not Implemented |
| NA96-24903 | Outlier Test in PPS Not Being Performed at 230 km |
| NA96-25701 | Remove DSP Hooks |
| NA96-26102 | Add a Version Number to the System Status Log |
| NA96-30601 | RPG Implementation to Support Pedestal Encoder Voltage Level Upgrade |
| NA97-03603 | Fix PPS Module A3148N_BUILD_3HOUR |

| | |
|---|---|
| NA97-05001 | Determine the Correct Hybrid Scan Reflectivity in Module A31432_DETERM_MAXVAL |
| NA97-17501 | USP Task Fault |
| NA97-17502 | PAUSE Hardcoded in Redundant Task |
| NA94-23504 | Three Hour Precipitation Accumulation Product Contains Erroneous Blotches of Accumulation. |
| NA97-25501 | Storm Relative Mean Radial Velocity Task Fault |
| NA96-27604 | Add Received Map Pointer Correction to PUPUP |